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ELECTRICAL REVIEW

[ILLUSTRATED.]

A WEEKLY JOURNAL OF

ELECTRIC LIGHT, TELEPHONE TELEGRAPH AND SCIENTIFIC PROGRESS.

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Western Electric Co's Electric Current Indicator.

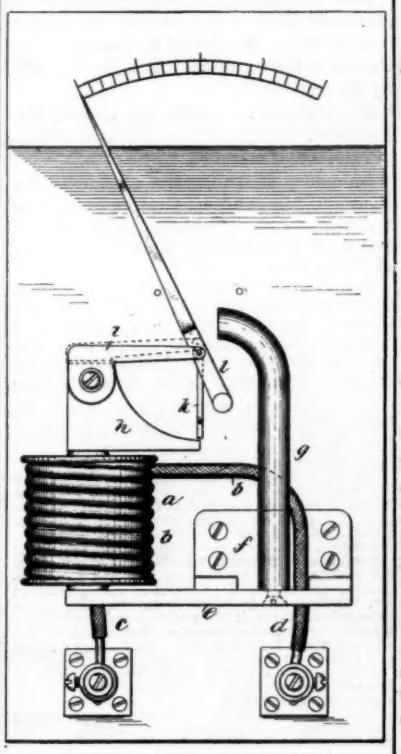
The electro-magnet *a* is wound with coarse wire *b*, connected with binding posts *c d*. The soft iron heel-piece *e* is extended, and supported by the brass bracket *f*. The lower pole of the electro-magnet is still farther extended by the soft iron rod *g*, mounted, as shown, upon the heel-piece, the upper end of the rod being bent, as shown, so as to approach the upper pole of the electro-magnet.

A screw is inserted through the heel-bar into the rod *g* for holding said rod in any position to which it may be adjusted. The upper pole of the electro-magnet is extended by the soft iron piece *h*. The adjustable brass carrier *i*, upon which the armature *k* and pointer *l* are pivoted, is mounted upon the upper portion of the soft iron extension *h*. The armature *k* is suspended at its upper end upon pivots, so as to hang vertically when there is no current passing through the coil of the electro-magnet. The magnet, when energized, acts upon the armature in opposition to the force of gravity. Thus the armature is moved and the needle deflected according to the strength of the magnetic field.

The side of the pole *h* next to the armature is concave, the radius of the curved surface being measured by the radial length of the swinging armature. The initial adjustment of the magnetic field is effected by the hod *g*, after which the final adjustment is affected by raising the pivotal center of the armature above the radial center of the curved surface of the pole sufficiently to cause the free end of the armature as it is swung by the attractive force of the magnet to approach nearer and nearer to the concave surface of the pole. Thus the attractive force of the pole exerted upon the armature increases over and above the increased magnetic power, on account of the gradual approaching of the swinging end of the armature to the surface of the pole. The armature is adjusted so that it will be moved a given distance for each additional ampere in the current. The uniformly graduated scale can thus be placed approximately in position with respect to the needle, and then the instrument adjusted to the scale.

The Bentley-Knight System at Allegheny, Pennsylvania.

The difficulties here are unusual, the grade being heavy and curves sharp, some on grades. The worst grade is one of over ten per cent., and nearly 1,700 feet in length. The system is conduit for about one-half mile, and overhead conductors for the remainder—about two and one-half miles. The conductors are one-half inch copper wires. The power house is located about one-third the distance from one end, and sends current both ways. The power house contains two 125 horse power tubular boilers, and a nominal 200 horse power Buckeye automatic engine, driving 4 Thomson-Houston constant potential dynamos, each giving nominally 250 volts and 100 amperes. They are coupled two in series for 500 volt potential in the line. Four cars are operated, each provided with two nominal 15 horse power series wound motors, arranged in multiple arc. Speed is regulated by a rheostat under the car platform, operated by the brake-handle. The cars are brightly lighted by four 16 candle power incandescent lamps in the center of each. The change from conduit "plow" to "trolley," and *vice versa*, is made readily during a momentary stop.



ELECTRIC CURRENT INDICATOR.

The heavy grades are surmounted with the aid of a cast steel rack laid alongside one rail, into which mesh spurs cast on the tread of one of the car wheels, giving a grip which is considered necessary in the circumstances. It is said that a car loaded with forty passengers readily mounts the long grade at a speed of eight miles an hour. They certainly cap the climax as to cost of fuel. The charge for natural gas, which is used under the boilers, is only $2 per day.

The road is not yet in full operation, but one or more cars are making regular trips daily.

Electricity and Dentistry.

Dr. George W. Whitefield, of Chicago, entertained the Chicago Electric Club, on the 6th instant, with an illustrated talk on "Electricity in the Dental Office." He rang the door bell, examined teeth, bored and hammered, and polished teeth; he used electrically-produced heat for drying out cavities, and he bleached those which were internally discolored, by electricity. Few present were aware of the many uses to which electrical energy is applied by ingenious professors of dental surgery. His illustrations were very apt, and largely original as well as ingenious.

One experiment was particularly interesting, and showed how slight a cause may work a deal of mischief in one's mouth, where one had considered the greatest of care had been taken. In a toothbrush handle the doctor had fitted a gold filling and an amalgam filling, and attached moisture-proof wires, connecting these to the poles of a galvanometer. The least moisture upon the fillings showed the presence of an electrical current—and when, after chewing a pickle, the doctor placed the two fillings in his mouth, the needle of the galvanometer fairly went wild. The experiment perfectly explains how, with fillings of unlike metals the best work of the best dentist may be destroyed by the electrolytic action thus set up, in loosening the fillings by dissolving the tissues in contact with the metal.

BUSINESS TRANSACTED AT THE ELECTRIC LIGHT CONVENTION.

A Comprehensive and Interesting Review of the Work of the Convention aside from the Reading of Papers and Discussions.

At the Pittsburgh Convention of the National Electric Light Association, Feb. 21, 22 and 23, the usual rapid dispatch of business was more noticeable than at any previous meeting. We presented last week a number of the papers read before the convention, and a general account of the work done from the beginning, at Tuesday noon, to the closing, Thursday afternoon. Several additional papers, with the discussion they provoked, appear in this issue under their proper heading.

We give in what follows a succinct, continuous account of the business of the convention, so that all our readers may readily find a perfect record without reading through the discussions which appear in full (or have appeared) elsewhere. As a matter of course the most business was transacted on the last day, and we give it full room:

FIRST DAY—TUESDAY, FEB. 21.

President Morrison, of Baltimore, calling the convention to order at 12 M., delivered the opening address. Major W. C. Moreland, of Pittsburgh, welcomed the delegates on behalf of the mayor of the city.

Invitation of the Engineers' Society of Western Pennsylvania, to attend their meeting that evening, was accepted, and the privileges of the convention extended to the engineers.

Letters and telegrams were received and filed.

The contribution of $1,150 from the several Westinghouse companies was received and a vote of thanks given the donors.

The report of the secretary and treasurer was read, showing a membership of 178, a debt of $98 and $971 in the treasury. (This did not include, of course, the Westinghouse gift.)

The executive committee made its report. Portions of it were approved. A few recommendations were laid over for discussion.

Messrs. Duncan, Moses and Weeks were appointed a committee to report on the recommended increase in the annual dues, from $10 to $20 per annum.

Prof. Geo. Forbes, of England, was elected an honorary member.

Upon motion of E. T. Lynch, jr., the president appointed the following committee on nominations and place of meeting: Messrs. Lynch, Weeks, Ridlon, Stanley, Garratt.

The committee on insulation, consisting of Prof. Elihu Thomson, Prof. Louis Duncan, Geo. Hamilton, T. D. Lockwood, Dr. Leonard Waldo, O. B. Shallenberger and Dr. Otto A. Moses, was continued.

SECOND DAY—WEDNESDAY, FEB. 22.

Upon motion of Dr. Otto A. Moses, Prof. E. L. Nichols, the successor of Prof. Anthony, of Cornell, was elected an honorary member of the association and his name added to the committee on insulation. Mr. E. G. Acheson, of Pittsburgh, was by vote of the convention added to the same committee, but on hearing of it he tendered his resignation, giving as the reason his connection with a wire and cable manufacturing company. The resignation was accepted with regret.

Mr. Duncan, of the executive committee, offered a previously announced substitute for Art. VIII of the constitution. It was adopted, and is as follows:

"Art. VIII.—The annual dues shall be $20, payable in advance, and shall cover the calendar year."

This changes the dues from $10 to $20 per annum, and does away with an initiation fee. In presenting the resolution, Mr. Duncan announced that the probable expenses of the association would be $3,000 per annum.

Mr. Frank Ridlon offered the following resolution, which was laid over one day:

Resolved, That Article IV of the constitution be hereby amended to read as follows:

The president and vice-presidents shall be elected by ballot to serve during the following meeting. The treasurer and the secretary who may be one and the same person, shall be nominated by the president, subject to the approval of the executive committee. The executive committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

THIRD DAY—THURSDAY, FEBRUARY 23.

The amendment to the constitution reported the previous day was first in order.

Mr. DeCamp moved to lay upon the table.

Mr. Ridlon hoped this would not be done. Favored electing the president from locality where meeting was held.

President Morrison thought the matter important and deserving of full discussion.

Mr. Leggett, of Detroit, agreed with Mr. Ridlon, but preferred that the chairman of the executive committee be elected from the city where the meeting was to be held. Said the convention had realized the advantage of this in the admirable arrangements made by Mr. Duncan at Pittsburgh.

Mr. Weeks, of Kansas City, said he understood the purpose of the amendment was to strengthen the hands of local parties in preparing for conventions. He said the matter had been suggested, not by him, but by others, with a view of carrying out certain suggestions that he had made with regard to holding a convention in the West. Continuing, Mr. Weeks said: "I have suggested that our next annual convention be held in Kansas City. One cannot fail to be struck by the lack of Western representatives. While in the West we have hundreds of plants—nearly every city and town in Missouri, Illinois, Kansas, Nebraska and Colorado being provided with electric light plants—still they have not sent delegates to our convention; and on speaking to them personally about it I could not induce them to do so, on account of the great expense of time and money necessary to come East to attend a meeting of the association. Now, it has been thought

that, by holding a convention in Kansas City, if wisely advertised for awhile, we might bring in all these elements. It was with a view of carrying that matter out that this amendment was suggested. It was, as I understood it, with a view of selecting somebody in that locality for president of the association who could accomplish the most for the association in carrying out this matter."

After some further discussion, Mr. Mason made the point of order that, as a committee had not been appointed to present this amendment, it was not properly before the house. The president, who had not presided at the time the amendment was proposed, on learning this to be the case, sustained the point.

Mr. Leggett then offered an amendment to the constitution, which adds after the first clause in Art. IV., the following. "And shall not be eligible for re-election for a next succeeding term."

The president appointed as the committee to report on this amendment, Messrs. Leggett, Weeks and Duncan, and requested them to report at this meeting.

An invitation from Benjamin Rhodes, of Niagara Falls, inviting the convention to meet there one year from next summer, was received and filed.

The special committee on revision of the constitution made their report, which, on motion, was made the special order for the first day of the next convention.

On motion of Dr A. F. Mason a committee of five on revision of the constitution was appointed by the chair, consisting of Messrs. Mason, of Boston, Leggett, of Detroit, Phelps, of New York, Stanley, of Bridgeport, and Porter, of Philadelphia.

The salary of the secretary and treasurer was made $900 per annum.

The committee to nominate officers presented their report through Mr. Garratt, naming for president S. A. Duncan, of the Allegheny County Light Company; for first vice-president, E. R. Weeks, of the Kansas City Electric Light Company; for second vice-president, A. J. DeCamp, of the Brush Electric Light Company, Philadelphia; for executive committee, Dr. Otto A. Moses, electrician, chairman; J. Frank Morrison, Brush Electric Light Company, Baltimore; E. T. Lynch, jr., United States Illuminating Company, New York; Frank Ridlon, of the Baxter Motor Company, Boston; W. L. Strong, of the Brush Illuminating Company, New York; T. C. Smith, of the Keystone Electric Light Company, Pittsburgh; E. F. Peck, Citizens Illuminating Company, Brooklyn. The committee (to whom was also referred the place for holding the next meeting) also recommended in their report that the next semi-annual convention be held in New York.

On motion of Mr. Glazier the secretary was authorized to cast the unanimous vote of the association. Mr. Glazier and Mr. Jesse M. Smith were appointed tellers.

The president and vice-president were then elected.

THE PRESIDENT: Gentlemen, I have the pleasure and honor of introducing to you your duly elected president. He will find the office of president of this association a pleasant one if the same courtesies shall be extended to him as have been extended to me. (Applause.)

MR. DUNCAN: Mr. President and Gentlemen—I should be devoid of feeling did I not appreciate the honor you have conferred upon me, especially when I recognize the fact that I am to succeed a man who, by his influence, as well as by the power of the gavel, which has been the only symbol of authority in this association, has welded together and made the association what it is to-day. Three years ago, in Chicago, a few representatives of electric lighting interests met and elected my predecessor, Mr. Morrison, as their president. From that time on he has continued to direct and control, with the advice and assistance of the executive committee, this association. It has grown in membership and influence, until to-day it represents in its membership millions of capital and the intelligence and brains of the electric light interests of this country.

I shall endeavor, gentlemen, to bring to the discharge of the duties of president of this association all the ability that I have, and I shall discharge those duties with fidelity to the best interests of this association. Promise is good, but performance is better, and you will be better able to decide upon the wisdom of your choice in the future than you are to-day, and I can only thank you for the compliment you have paid me, and ask your indulgence for my failures and for probable inconsistencies in the rulings of the chair, until such time as you have proper by-laws and parliamentary rules for your government. I have no doubt, gentlemen, that you will place the same confidence and trust in the integrity of the chair in the future which you have in the past, and with your co-operation and assistance, and with the aid of the retiring president, I hope and trust that this association will do better, or as well at least, in the future as it has done in the past.

Thanking you for your consideration, I conclude by assuring you that I will endeavor to discharge the duties of the office to the best of my ability. (Applause.)

Before proceeding with election of executive committee, it was decided to select the place of next meeting, and Mr. Foote of Cincinnati, and Mr. Leggett, of Detroit, spoke in favor of Cincinnati, Ohio, stating that the Ohio Valley Centennial would be held in that city at the time of the convention, and many interesting industrial and electrical exhibits could be seen. The motion was then made to substitute Cincinnati for New York in the report of the committee; this was lost by a vote of 14 to 44.

MR. CALLENDER moved that the meeting be held at some of the summer hotels in the vicinity of New York.

MR. GARRATT stated that the committee had in mind, when making the report, New York and fixings.

MR. CALLENDER'S amendment was put and lost.

The recommendation of the committee, that New York be the place of the next meeting, was unanimously adopted.

THE PRESIDENT: We will now take up the regular order—the selection of the executive committee. The secretary has read seven names recommended by the executive committee. The constitution calls for six.

MR. DECAMP: I would suggest, without meaning any disrespect to the gentleman, that Mr. William L. Strong's name be stricken from that list, reducing the number to six. I make that amendment to the report simply because I think there is not any probability of Mr. Strong's attending to the duties of that committee. The rest are all gentlemen who are available and who will doubtless act with the committee.

MR. DECAMP'S amendment, withdrawing the name of Mr. W. L. Strong, was carried.

THE SECRETARY then cast the ballot of the association for the following named gentlemen as members of the executive committee: Dr. O A. Moses, chairman; Mr. J. F. Morrison, Mr. E. T. Lynch, jr., Mr. F. Ridlon, Mr. T. Carpenter Smith, and Mr. E F. Peck.

MR. GARRATT then moved that the invitation courteously extended by Mr. H. C. Davis, president of the New York Electric Club, be declined, with the thanks of the association.

DR. MOSES: Is it possible that my ears deceive me—that the invitation is declined?

THE PRESIDENT: The motion is that the invitation be declined.

MR. GARRATT: I am asked, why? Because I do not think the New York Electric Club House is an appropriate place to hold a convention. I declined it with thanks. I specified the invitation as courteous. I imply no lack of courtesy to the club or lack of kind feeling on the part of the association, and I do not think it wise that the convention be held in the club house.

THE PRESIDENT: My recollection of Mr. Davis' telegram is not that it invited the convention to meet in the club house, but simply offered the associations the courtesies of the club

MR. GARRATT: May I withdraw my motion, Mr. President?

THE PRESIDENT: With a great deal of pleasure. The secretary gave the dispatch to the committee. The dispatch read in substance that they urged on the association the selection of New York as the place of meeting, and offered the association the use of the club house while the convention was in session.

MR. GARRATT: May I substitute the word "accepted" in the place of "declined"? It is a slight difference. [Laughter.]

MR. W. L. CANDEE: Your interpretation of that telegram is the correct one. The club house would not be anywhere near large enough to accommodate the association, and it was the intention of Mr. Davis to give the convention the same liberties as the members have during the convention week.

THE PRESIDENT: With the consent of the convention the gentleman will be permitted to make that amendment.

MR. GARRATT'S resolution, as amended, was adopted.

THE PRESIDENT: I suggest that some gentleman make a motion that the resolution offered by Mr. Garratt be transmitted to President Davis, of the New York Club, by the secretary.

MR. DECAMP: I make that motion, Mr. President.

The motion prevailed.

On motion of Mr. Duncan, a committee on transportation was appointed, consisting of Mr. T. C. Smith, of Pittsburgh; Mr. Geo. F. Porter, of Philadelphia; Mr. Geo. S. Bowen, of Elgin, Ill.

DR. MOSES: I have drafted resolutions which I know will meet with unanimous approval on the part of the convention. I will make no preamble, because you all have in your minds whatever I would say on the subject. I will simply read the resolutions:

WHEREAS, It has pleased Mr. J. Frank Morrison to insist upon not being re-elected to the position of president of the National Electric Light Association, which he has continuously held since its organization; and

WHEREAS, We have tacitly agreed, at our successive re-elections of him, to allow him to retire (as he has invariably requested at each meeting) whenever the interests of the association would not suffer by such action; therefore, be it

Resolved, That we, the National Electric Light Association of America, representing in our midst every department of electric light and power industry, express our deep regret at the decision of Mr. Morrison not to allow us to keep him at the helm, where, through many storms and quicksands, through much fair weather and some foul, he has successfully guided us to the haven where we now find ourselves; and be it further

Resolved, That a vote of thanks be given Mr. Morrison for the disinterested devotion, enthusiasm and steadiness with which he has administered the affairs and presided over the proceedings of our conventions, and that, further, we tender him our best wishes for his deserved enjoyment, through a long and prosperous life, of the beautiful prospect of the great work he has done in founding, fostering and cherishing the National Electric Light Association.

MR. DUNCAN: In rising to second that motion I desire just to make one remark, which might probably have been better made at an earlier stage of the proceedings of this association. There has been a criticism made in regard to our president, which, to my mind, was absolutely unjust and unfair, and I cannot omit at this time to bring it to the attention of the association, as one of the facts which influenced Mr. Morrison in absolutely declining a further re-election to the office of president of this association, he having engaged in another business—the motor business—and it seemed to him that his action as president of this association, in the appointment of committees and in other ways, might be construed in some way as being influenced, in some measure, by his own personal interests — I say, having thought that his official action might be construed in that way, he utterly and absolutely, in a conversation with me, refused to be present at this meeting unless he was assured that some steps should be taken for the election of a successor. I endeavored to reason the matter with him, both by verbal and written communication, but without any result. I simply mention this matter now to show that he best interests of this association has, in his hands, always been protected, and that, while the considerations I mentioned to you have influenced him to a large extent to the final and decided step which prevented him from further continuing his services in this association, they also resulted in the recommendation which was made to this convention some time since. In rising to second this resolution, I want, at the same time, to say that, so far as my own preference is concerned, and so far as my wishes for the well-being of the association are concerned, I should have desired to have him remain at the head of this association, but this seemed to be a stumbling-block in his way, and I simply mentioned it so that the association can see how the matter stands. I second the resolution, Mr. President.

MR. LEGGETT (in the chair): I desire to say that I think I have been twice placed upon this committee, once at Boston and once here at Pittsburgh, relative to this change in the constitution, and that this was suggested to me in the same manner in which it has been suggested to Mr. Duncan by Mr. Morrison himself at Baltimore, and my zeal in the matter has grown out of his own desire to be relieved in that embarrassment.

Is there anything else to be said on the motion?

MR. MARTIN: I would like to support the motion by proposing that as Mr. Morrison has given the association three years, the least that we can do is to give him three cheers. I therefore propose three cheers for Mr. Frank Morrison as president of this association.

The cheers were given.

The resolutions proposed by Dr. Moses were unanimously carried.

MR. MARTIN: I would like to offer a resolution in connection with that just passed, before any further business be taken up The resolution is as follows:

Resolved, That the resolutions adopted in regard to the invaluable services of J. F. Morrison as president for three years, be suitably engrossed and given to him, and that a committee be appointed to carry out this work and to make the presentation.

The resolution was seconded by Mr. Duncan, and carried.

MR. DUNCAN: Before any further business is taken up, I desire to move that the thanks of this association be tendered to the telephone company of this city, of which Mr. Metzgar is the manager, for the courtesy extended to this association by placing a telephone at its disposal in the executive committee's room.

The resolution was carried.

THE CHAIRMAN: The chair will appoint on the committee provided for in Mr. Martin's resolution, Mr. Martin and Dr. Moses.

A dispatch was received from Mr. Arthur Steuart, from Washington, as follows: "Met the committee to-day; they are favorable to our plans."

MR. DECAMP: I would like the privilege of offering the following resolution:

WHEREAS, In the death of Mr. W. S. Frear, Secretary of the Brush Company, of Buffalo, N. Y., the association has sustained a severe loss;

Resolved, That the association hereby expresses its deep regret at being deprived of the fellowship and counsel of so young, promising and active a member, and that it further hereby tenders its sincere condolence to the many friends and the family of the deceased.

Resolved, That the secretary make the communication of the above to those who have been thus sorely bereaved.

The resolutions were adopted.

The convention adjourned *sine die* at five o'clock P. M.

Leather Belting.

PAPER BY MR. CHAS SCHIEREN AT ELECTRIC LIGHT CONVENTION, AND THE DISCUSSION IT PROVOKED.

ABSTRACT OF PAPER BY CHAS. A. SCHIEREN ON LEATHER BELTING.

In the early part of this century the first attempts were made by English machinists to transmit power by means of bands or straps made of leather. This transferrence of power from one line shaft to another needed a peculiar quality of material—one that combined pliability, solidity, and strength—and leather was the only known substance which suited that purpose. Many experiments have been made since then with other materials, such as rubber, textiles, wood, paper, and even iron and brass; also belts woven of horse hair, etc.; but none have been able to supersede leather, and even to this day it is universally acknowledged,

"There is nothing like leather,
When well put together."

Belts made of leather are given the preference wherever they can be used; and it is somewhat strange that the machinery world of to day knows so little about the origin, progress, and growth of an article that plays such an important part in the transmission of power as leather belting.

Waxed thread was used to sew the belt, and light rivets were used in the construction, which made it run easier; but, as the leather was not stretched, the belts would stretch all out of shape, and the pulleys had to be flanged in order to keep them on. Not until Mr Wood conceived the idea of stretching leather before being cut into belting, was this trouble entirely obviated, and a flange on the pulleys no longer necessary.

Mr. J. B Hoyt deserves credit for having established a *standard* for belting which is reliable, and cannot be surpassed, unless, indeed, the nature of the steer hide changes. The trade everywhere has been compelled to adopt this method of making belts, because consumers have been educated up to it, and many of them will buy nothing else.

About 1865 our manufacturing industries developed to an enormous extent, and immense factories were erected, which required engines of great power that could transmit from five hundred to a thousand horse power.

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This created a demand for very wide main driving belts, and great difficulty was experienced by belt manufacturers in making wide main driving belts over thirty-six inches which would be of uniform solidity and equal tension. Whole hides contain an average of thirty-six inches in width of solid leather, and never exceed forty-five inches, while orders came in from all sides for main driving belts from fifty to seventy five inches in width. Ever since this time, experiments have been made on wide belting; and to-day we have reached a state of perfection that leather belts of any desirable width can be constructed.

A main driving belt is now generally made on the following plan: Take, for ins ance, a double belt six feet wide.

The lower or running part of the belt consists of two pieces of leather joined together parallel; then a thirty-six inch piece is placed in the center of the lower two belts, and two end pieces filled out to the required width, and all joined with parallel joints. This makes a belt of uniformly solid leather and equal tension and one which is bound to run perfectly smooth and straight. Powerful stretchers have also been invented which can take in any width of leather.

Alexander Brothers patented a method by which they can use side leather and accomplish the same result. However, they do not make a parallel joint, but simply bitt the pieces together, as above shown, and then cement and rivet the same.

Eastern belt makers were the first to produce a light double belt, with neither rivets nor fastenings, claiming that rivets and burrs were not necessary if a belt was properly cemented. They are used for machines running at a high rate of speed.

About 1864, N Clark, of Boston, Mass., made that line of belting a specialty. He produced a belt which would probably find great favor to-day for running dynamos. His method was to split the pieces of leather to a perfectly even thickness, and then cement them together. This made a double belt, rather thin, but well calculated for high speed. Mr. Clark retired from business about ten years since.

When the electric light first came into use, electricians found it exceedingly difficult to get a belt suitable to use on dynamos. All of the belts which they tried seemed to lack something, and ofttimes the heaviest and most carefully made leather belts failed to do the required work. This problem received special attention by some of our most enterprising belt makers, and various methods for making these belts were introduced, with more or less success. About five years ago the writer experimented on producing a belt which would be particularly fitted for transmitting power when run at a high rate of speed. I considered the stretching process of leather belts the most important, because the steer hide by nature forms a peculiar shape, having fine and solid fibers on the back, and, when rounding off towards the belly, with loose, coarse fibers. To get, therefore, a perfectly flat piece of leather of even tension from the center of the hide it needs the utmost care.

These belts met with great success and were so well calculated to use on dynamos, that we named them "electric." Many of you gentlemen have no doubt heard of our "electric belts," and some of you have probably used them or seen them in operation.

However, no belt has ever created such a sensation in the trade as leather link belting.

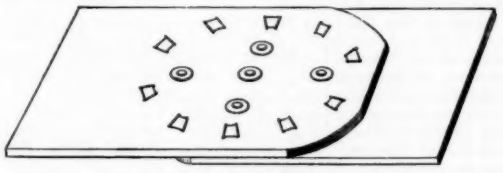
This is a comparatively new article in this country, having been introduced by our firm some two years ago. Since that time we have made so many improvements in this line of belting, that it can now be used on any kind of machinery. During the past two years we have sold hundreds of these belts for use on dynamos; and all are doing excellent work, as may be proved by many testimonials, etc., which we have received. They are made in the following manner: Small pieces of solid selected leather are dressed with tallow and neat's foot oil, which acts as a lubricator to the joints of the pins. The leather is then put through rollers, and made very solid. It is then cut into small links. This process makes a link of remarkable tenacity and strength, and one which will stand more strain than a piece of hard rolled sole leather. The links are then carefully assorted as to thickness, and the belt built up to the required width. It is of great importance that each belt be made up of accurately assorted links, in order that an even width and perfect-running belt may be secured.

An inexperienced person, upon seeing one of these link belts running on a dynamo, would naturally think that the belt was loose, and needed tightening; but these belts have such a remarkable grip power, that though, when running, the upper side of the belt is so loose that it almost describes a semi-circle, the underside is as tight as possible. Many electric concerns have used and are using our belt, and we can furnish to any who are interested a volume of testimony as to their adaptability for dynamos and electric light machinery. Leather link belt will in time find great favor with belt users. They are more pliable than any flat double belt can possibly be made; and for belts running at right angles I claim that they are the only reliable belts for such a position that will give satisfaction.

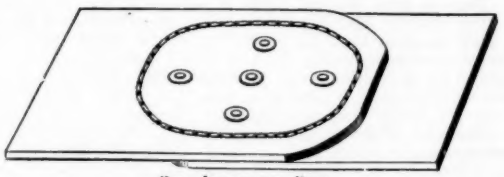
MR. POPE: I would like to ask the gentleman with reference to the wearing of the edges.

MR. SCHIEREN: The first belt which I made up, about six years ago, is still running Before I came to this convention I took it down and told my man to take it apart, to take about six inches off it, in order to see the elongation. We have kept perfect time as to that belt. The belt is 28 feet 7 inches long and it had stretched eight inches in the first three months. After that there was no further stretching. We took the belt down, examined it closely, and found no elongation whatever. This belt is three inches and a half wide, one inch thick, and transmits fifteen horse power under the following circumstances. It has two 38-inch pulleys, and the pulleys run at the rate of 125 revolutions.

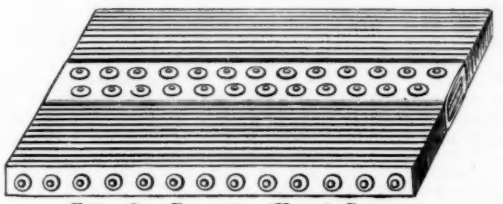
MR. POPE: I would like to ask what has been the experience in Europe during the length of time that these belts have been running there.



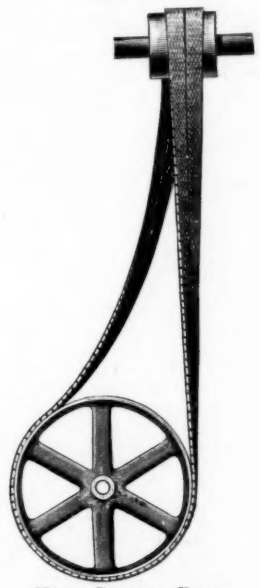
OLD STYLE BELT.



OLD IMPROVED BELT.



EDGE CUT BELTING. (HOWE'S PATENT.)



HALF CROSSED BELT.

DIAGRAM SHOWING PARALLEL SEAM OR JOINTS FOR WIDE BELTS.

MR. SCHIEREN: My attention was drawn to these belts when I went to Europe twelve years ago. I looked into them at that time and thought very little about them. About six years ago I went to Europe again and looked at them and thought better of them. I thought there was something in that belt that filled a gap in this country, and I determined there and then that I would try them here. However, other matters came up, and I did not try them until three years after that. In reference to the experience in Europe I will state that two years ago I was there, and met several electricians, and got from them some very valuable information with regard to the use of linked belting in running dynamos. Their dynamos there are run much slower than yours here. A great many of them favor these linked belts. They only use one pin there; and engineers told me that it takes four months before the pin adjusts itself to the rounding of the pulley. Although there are several patents there now, they make belts similar to what are made in this country. On the whole they speak of them very favorably.

MR POPE: One other thing suggests itself, and that is as to the rapidity of the alternating system—running at 1,600 revolutions; whether in that place the link belt would be preferable or as good as others.

MR. RIDLON: I have used one of these belts, three and a half feet wide, at a speed of 2,000 feet per minute. The only fault I can find with it is the stretching We took it out two months ago, and there has been no trouble since

MR RICE: I would like to ask Mr. Schieren in reference to the amount of power consumed by this belt, as compared with ordinary belting. Does the belt itself use more or less power—I mean for the bedding of the belt over the pulley?

MR. SCHIEREN: I am sorry to state that I am not a civil engineer or a mechanic; I am a belt maker. If you come to me and say that you would like thus and so done, I am ready to go into it and to give it my attention; but if you ask me certain questions, as, can that belt do thus and so at a certain speed, I cannot answer. My experience in linked belting has been this, that it will transmit under certain circumstances more power than the ordinary belt. It will do it every time. In some instances we have put on an eight inch belt and have taken off a twelve inch belt. In some instances we have put on a twelve inch link belt and have taken off a ten inch belt; and it would not drive with a ten inch belt, owing to the difference in circumstances. So, to-day, I may say that we are ignorant in regard to the amount of power, comparatively, that they will drive. We are constantly making experiments and improvements, and are gathering valuable information in that way; but I am sorry to say that I cannot answer your question intelligently.

MR. LAW: I would like to ask Mr. Schieren if he has had any experience, or enough experience to determine the amount of damage that oil does to this belt, as compared with ordinary double belting. In some classes of our dynamos a large amount of oil is saturated into the belt; and I would like to know if that has any effect upon this linked belt.

MR. SCHIEREN: So far no claim has been made in that direction. Of course you will understand that if the leather lies on the edge it exposes the fiber of the leather more than if it lies on the smooth surface of the leather. Leather is a great absorber. I use blotters of leather in my office, because leather absorbs a fluid at once. No doubt you have noticed this in running your dynamos. It absorbs oil very fast. To my mind, to answer your question, I think that the link belt would absorb oil more than the other belts do, although I have had no experience. It is necessary that the linked belt be exposed on the edge, and therefore it would absorb quicker than the other way. But that could be obviated by using a dressing which would close the pores of the exposed part of the belt.

MR. DECAMP: Is not one of the advantages attending the use of the linked belt in the fact that it can be run slack? That being the case, is its use confined to horizontal belts? In that case it would be necessary to have the slack side on top, it is not possible.

MR. SCHIEREN: That is true. The link belt will only run successfully if the slack side is on top. If the slack side is below, the belt will very soon flop on your floor, and your power is gone. They do not run successfully in that way.

MR. LAW: What sort of success have you had with almost perpendicular belts?

MR. SCHIEREN: We have had very good success. The only trouble with perpendicular belts is this: At first these link belts stretch considerably. I have learned a great deal since I undertook to make belting. I have alluded to these edge-cut belts, which are enormously strong. The Englishmen recommend it and use it for their slow, heavy power. I have seen in England six-inch belting transmit power that I know my twenty-four inch belting would hardly dare tackle. It was edged cut belting an inch and a half thick and bolted together. If you take a piece of leather that is three feet wide and one inch thick and stretch it in a stretching machine, you will stretch probably ten per cent. of that belt under certain circumstances. If you take and cut up that piece of leather into small pieces of two inches and bolt them together you cannot stretch it a foot. Why is this? It is because the little pieces seem to have more elasticity than the longer pieces have, or more than when they were combined together. There lies the great trouble in these linked belts. I have studied the question very deeply; and to overcome that I have made a certain method of preparing the fulling—these small pieces—with a dressing that tends to toughen them and tends to harden it at the same time, so that it will not stretch as much as the whole piece of leather would. The article of belts that we make to-day are full of that material, that all that they will possibly take, and the leathern is even tougher than steel; it will cut steel.

MR. JESSE M. SMITH: One of our greatest sources of loss of power in fast running belts—that is, in belts running 5,000 or 6,000 per minute, is the imprisonment of air between the belt and the pulley. It amounts to carrying the belt away from contact with the pulley; amounting sometimes to a quarter of a revolution, or a quarter of the circumference of the pulley. Experiments have been made that prove that a belt will drive more power if holes are punched through it than a solid belt will do when run at high speed. The link belt which Mr. Schieren has spoken of has, of course, a large number of holes perforated through it. For that reason it is very easy for the air which is imprisoned between the periphery of the pulley and the inside of the belt to get out and permit a very much closer contact. I think it is a fact, and that it has already been proven in a great many cases, that a linked belt will transmit more power for the same width and the same belt, with reference to the exposed part of the pulley, than will an ordinary flat belt.

MR. T. C. SMITH: I can say, in answer to Mr. Rice's inquiry as to the bending strain of belts, that, without having made any particular examination of it, any one who has looked at an ordinary belt running at a high rate of speed, will notice that the speed of the belt is not sufficient to overcome its stiffness and make it lie right on the pulley; but a linked belt will in all cases lie right on the pulley, and form a true tangent to the edge of the pulley wherever it strikes it. The flexibility of the belt is so much greater than that of an ordinary belt that the bending strain is less. With regard to vertical belts I will say that we had a belt of that kind, running 7,500 feet per minute, and we found that a link belt, while running at that tremendous velocity, would carry more power, and stick closer to the driving pulley. They seem to have a peculiar way of sticking to the pulley very closely. I have had very little experience with belting; but we used one of the eight-inch belts, and then we tried a linked belt, and it did the work first rate; but we had to abandon it for a very curious reason; and that was that when running the link belt at such a high rate of speed it caused the belt, in coming down on the pulley, to make such a terrific roar that it made the engineer sick; it gave him a nervous headache; it was due perhaps to the fact that our station was only six feet from the floor to the roof, and with the 300 horse power dynamo in a room only 20x30 it made a terrible noise. But, so far as the belt itself was concerned, its work was satisfactory. With the other belt we got rid of that trouble entirely. There are a great many things that come in in the practical work which we cannot see when a thing is designed; and it is not always what seems to be the best thing to put in that you can keep there.

A very neat and convenient memorandum book was presented to the attendants by *Modern Light and Heat*. It contains in the back a valuable list of "definitions and formula for unprofessional readers."

The ladies' parlor, where the REVIEW's headquarters were, overlooked the Monongahela river and its picturesque banks.

The Monongahela House management tried in every way to make the electric light men feel at home.

THE UNDERGROUND QUESTION.

It Comes Prominently to the Front at Pittsburgh.

DISCUSSED AT LENGTH BY ELECTRIC LIGHT MEN.

Underground Wires and the Alternating System.

MR. LEGGETT'S PAPER ON THE "UNDERGROUNDING OF ARC LIGHT WIRES."

MR. WELLS W. LEGGETT, president of the Brush Electric Light Company, of Detroit, read a paper on "The Undergrounding of Electric Arc Light Wires." The points of the paper will be found in the following:

Municipal and legislative authority seeks to compel the burying of all the wires without discrimination, and to cast upon the parties interested the burden of finding a practical measure to accomplish the end. It is an undoubted fact that to successfully underground electric light wires involves simply and solely a question of expense. But the expense may be so great as to be absolutely prohibitive.

Electric arc lights may be successfully trained in the air on poles, and any underground system is practicable which can produce the same system. With the underground telegraph and telephone wires the electrical difficulties are the same, and moisture must be excluded from the wires, insulation must be good and induction reduced to the minimum, especially between adjacent lines. In both, however, leakage from the lines, due to imperfect insulation, may be confined within limits by additional battery force. The battery acts like a pump sending water through a leaky pipe. The water may all escape before reaching the discharge end, but with a more powerful pump, while increased pressure will cause greater escape through leakage, a limited quantity may be discharged and accomplish the purpose sought. For this reason underground telegraph and telephone wires may be operated with a measure of success.

Operations looking to the undergrounding of arc light wires have been prosecuted on a large scale in New York, Brooklyn, Chicago, Philadelphia and Washington. Notwithstanding all reports to the contrary, no arc light line has ever been buried in New York City. Experiments have been tried in Washington, but proved a dismal failure. In Chicago it had the same result. At Detroit the Thomson-Houston Company employed a cable of the most expensive and approved character in the Dorsett conduit, and the mechanical work was of the finest. While the cable was new the result was fair, though loss by escapage rendered it impossible to reproduce normal lights. It was found impossible to operate telephone wires in the same or adjacent pipes.

The company abandoned the system, and when its cable was removed it was found that the insulation had so rotted and softened it that portions of the wire were stripped bare in many places. Telephonic and telegraphic, or even incandescent wires can be buried, but no system has ever, or probably ever will, be adopted which will solve the question of burying arc lights underground.

The president announced the convention ready to hear remarks on both Mr. Leggett's and Mr. Jesse M. Smith's papers.

DR. MOSES: I have the pleasure of announcing to the convention that we have in our midst this morning one of the most distinguished electricians of England, Prof. George Forbes, to whom the courtesies of our association have already been extended. As he is full of ideas, even to overflowing, he will perhaps allow us to puncture him somewhere so as to enlighten us. I hope that he will give us his views in the discussion of these various papers, or in making any suggestions which he may think apposite to the subject. I know that it will give us all very great pleasure to listen to him.

THE PRESIDENT: The convention will be pleased to hear from Prof. Forbes.

MR. FORBES: While I appreciate the honor you give me, I feel that on the particular points which have been raised at the present session there is not a great deal that I can say which would enlighten the people here in America as to what has been done in Europe. At every step as I go through different cities, I see how enormously ahead you are over us in England. A great deal of the subject of the papers which have been read have referred to the question of insulation, and as to the laying of overhead and underground conductors. Our experience in England, of course, as to underground conductors is absolutely nothing, almost, for the simple reason that our people will not allow us to put our conductors underground. The public in England have a strong feeling that there ought not to be any overhead conductors; they would not allow wires on poles as you have them here—which is a very cheap and convenient method; and our telephone wires have hitherto been carried from roof top to roof top—standards being erected on the roofs; and there is a general feeling among the public that electric light wires ought not to be overhead and ought to be underground. An electric light company also feel that they would prefer to put their wires underground. The opinion seems to be different over there to what it is here. The idea in England is not so much to make a cheap outlay at the start, as it is to make an efficient system—a system which will work afterwards. It is the general opinion of a great number of companies that the best arrangement could be got by underground work. However, Mr. Chamberlain, in 1883, thought it wise to practically prohibit electric light companies from putting their wires underground. The consequence was that for several years after that it was absolutely impossible to start a central lighting station. At the present moment the demand for light from central stations in England has become so great that the companies who are capable of doing the work are determined that they will satisfy the public demand; and the consequence is now that at the present moment central stations are being started in London and in other towns, but always on overhead systems. That is what the government has driven the electric light people in England to. I may mention that the insulation which is used in electric lighting overhead work in England for the alternating current, where 2,000 volts are used, is very superior to what you are using over here. The best possible insulation, of india rubber and tape of several servings, is being used in the central station lighting which is done on a large scale there, viz., from the Grosenvor Gallery, London. I have always thought that that was very wise; but I must say that from inquiries here among those who have been using alternating currents of high potential I find that a less expensive wire is certainly doing admirably, and I think it is just possible that we have, perhaps, overdone the matter in England in the way I speak of

MR. J. E. LOCKWOOD, of Detroit: I would like to ask Prof. Forbes a few questions with regard to underground wires in England. In 1881 and 1882 I had occasion to be in London and investigate somewhat while there the underground wires of the arc light company, or of two companies especially, and they were the Brush Company operating the Brush system, and the Electric Light and Power Generator Company of London, operating the Weston system. I understood while there that within one year's time the Brush Company were forced to renew three times their cables which they had laid down in the lower part of London, and that each time they put in the kind of insulation that the Professor speaks of as being preferable in England—the india rubber insulation; their cable being laid at that time by the India Rubber and Gutta Percha Telegraph Company. I do not remember as the Weston Company had replaced theirs so many times but I think they were replaced twice. I would like to ask Prof. Forbes if he can give us a few points with regard to these companies, and whether they were ultimately successful in getting a cable which would stand the potential.

MR. FORBES: I cannot answer that quite fully. I can support what you say has been said about the failure of the Brush Company's cables; but I do not think that the statement is correct that they were the work of the India Rubber and Gutta Percha Telegraph Company. I do not think that that was the case. The cables certainly were continually giving out faults in different parts; and enormous quantities of the cables had to be laid; and, even when they were working at their best, the insulation on the line varied enormously with the weather; so much so that on some days it was really almost impossible to work them. Eventually, as was stated just now, the whole of the cables had to be taken up. The best underground cables that I know of are at the works of the India Rubber and Gutta Percha Telegraph Company, where they have had their cables lying for about six years, and lighting the whole of the arc lights in their large works. They are laid in a conduit, which, however, is not water-tight, and the cables in some parts are dry, and in some parts are wet, and in other parts are alternately wet and dry; and they really undergo serious changes by the action of the water, as could be expected, and yet they have been maintained admirably during the whole of that time. I think that is all the information that I can give on that subject.

MR. MORRISON: I was not present when Mr. Leggett read his paper, and am not familiar with the details of it; but I wish to say this: Be careful how, as an association, you deal with the question of underground wires, and also be careful how you put yourself on record by taking the ground that such a plan of laying wires is not feasible. I do not intend to take any part in this discussion, either pro or con. Of course I am opposed to underground wires. So is every man who has money invested in electric light. There are a whole lot of things that we are opposed to, but the reasons why we are opposed to them would not look well in print. (Applause.)

MR. SUNNY: The statement was made this morning, in the very excellent paper read by Mr. Leggett, that while it was entirely practicable to work telephone and telegraph wires underground, it was not practicable to do so with electric light wires. I remember distinctly that six years ago, when the question of putting wires underground in Chicago first came up, the telephone interest gathered its experts together, and, in meeting assembled; they each and every one of them avowed, with all sincerity and earnestness, that while it was possible to work telegraph and electric light wires underground, it would be utterly impossible to operate telephone wires in that manner. The amount of crow that we have been compelled to eat in that time can be estimated upon when it is understood that there are 2,000 miles of underground wire working in Chicago today. As a matter of fact, the whole electrical interest opposed the measure and left no stone unturned to defeat it. The more they fought the greater became the general clamor for the removal of the wires. The same thing occurred to which Mr Leggett referred as having occurred in Detroit; the statements put forth in good faith and all truthfulness by the electrical fraternity were discredited by everybody on the other side. The authorities exercised their power in its severest form by ordering the removal of every pole and wire from the public streets within a specified time. The prohibition included the entire city of 48 to 60 square miles—acres upon acres of which are vacant, miles upon miles of the streets of which are uninjured and sparsely settled, and alleys, in passing through which one instinctively holds his nose and breathes as little as possible.

The point that I think can be made is, that that it is not the best policy to fight a measure in which the public seems to be so greatly interested, but to find a way to give them 10 or 15 per cent. of what they ask for, if in reason it can be done. I think now, that had this course been pursued in Chicago, that we would now be able to string wires in the air outside of a limit of two or three square miles. Chicago has a thousand arc lights on underground circuits in the center of the city, the greater number of which are in the districts served by the main station located on the Chicago river at Market and Washington streets. Most of the lighting is east of this point, so that 25 circuits or 50 wires run practically together for 2,000 or 3,000 feet. When this station was established, several months ago, a conduit of 12 creosoted wooden tubes was put down, to connect with the Dorsett conduit, built four years ago. The Dorsett conduit is made up of pipes having seven ducts or holes two and a fourth inches each. Six lead cables of $\frac{5}{32}$" insulation, No. 6 gauge, were drawn into each duct. Lead cables were used, in preference to anything else, because of the difficulties experienced in maintaining the insulation where other makes—a good many of them considered first-class—had partly or wholly failed. Many of the conductors having no lead covering have done and are doing good service in various parts of the city, but in the business portion, where the earth is saturated with water gas and sewer gas, which circulates more or less freely through the conduit, nothing but lead seems capable of withstanding their influence. The 6 cables in each duct were made into three circuits—3 positive and negative—and this arrangement is probably responsible for some of the trouble experienced. It was found that although the insulation measurement of the lead cables in the conduit was very high—considerably above a megohm—and the insulation beyond the point where the lead cables ended and where some other wire was used was, say, 500,000 ohms, a short circuit would form, generally within 1,000 feet of the station, between the two sides of the circuit. The heat generated at the point of the short circuiting would melt the lead in the adjacent cables, so that in one instance all six wires were rendered useless. Where this occurred in the Dorsett conduit the destruction did not go beyond the six wires, while in the creosoted wooden tubes, on another occasion, not only were the six wires destroyed, but the inflammable material of which the conduit is constructed resulted in the burning out of the entire conduit and the 60 cables in it. The cold weather of three months had frozen the earth to a depth of four feet, but when the street was opened it was found that the fire had taken the frost out of the earth below a foot from the surface, and that there was left for a distance of 12 feet a few charred sticks, the bare copper wires, and in the bottom some lumps of lead. Iron pipes were put in, and lead cables of five thirty seconds insulation used, four of which were put in each duct or iron pipe. This heavier insulation, coupled with the redistributing of the circuits, so that positive wires are grouped and kept away from negative wires, will probably result in eliminating this source of trouble.

Looking for the cause of these burn-outs it was found that they occurred on circuits carrying as few as 20 lights, or 900 volts and 10 amperes, and on circuits carrying 48 lights, or 2,160 volts and 10 amperes. They generally occurred near the station, although there was an insulation of $\frac{5}{32}$" between the two sides of the circuit measuring considerably above a megohm, and there were weaker places beyond, indicating that the nearer the station the greater is the liability of short circuiting.

It seems incredible that the $\frac{5}{32}$" insulation around each conductor would not carry this voltage, while the same make of cable of $\frac{5}{32}$ carries a greater voltage in another part of the city. We could not in any instance of a burn out find that an abnormal resistance had entered the circuit beyond the place where the burn-out occurred. On the contrary, as soon as the damage was repaired, it was found that the circuit was in good order. Without being entirely at rest as to the exact cause of burn-outs, we have adopted what might be called a whip handle method of insulation, very heavy at the station and tapering towards the outer end of the circuit. This, it is expected, will enable the conductors to hold the current within them under all conditions.

So much work has had to be done in the main route on account of the burn-outs, that we have had to make almost constant use of the manholes in the conduit. We find now that these manholes are all too small, and must be increased from 3' 6" diameter to 6' if possible. The suggestion is made that the latter size ought to be secured wherever possible, because of the impossibility of properly putting away the labyrinth of wires and cables that must be provided for at these points.

MR. T. C. SMITH: I wish to state that our company here in Pittsburgh is probably as much interested as any company in the country in aerial wires. We have an enormous amount of pole line already set up in this city, and we are doing immense business from that pole line; and I do not know that we should feel inclined to take the whole of that wire down, and go underground within a year, or within two years. But it is very evident that the public demand is urgent, that the wires be put underground wherever feasible, and our company, without being asked by the city, and without any ordinances being passed to compel us, has voluntarily undertaken to try the experiment thoroughly. We have seen a great many people try to put their wires underground, and in most of the cases which have come under my personal observation, the work has been done in such a manner that it is not a wonder that the cables burned out, or that they ever got current through them. As Mr. Smith, of Detroit, has remarked, it is much more an economical question than an electrical one. With regard to one of the conduits of which Mr. Leggett spoke in his paper, the conduit in Chestnut street, Philadelphia, I happened at the very time that the conduit was being, put down there, to be connected with another company in Philadelphia which was also putting in underground conduits. The underground conduits which our company laid were nothing but a lot of tin tubes put in a wooden box filled with pitch, and we hauled into it first glass, lead covered, insulated cables. We run them for six or seven months without the slightest hitch and without a single burn-out. At the time that the cast iron conduit was laid in Chestnut street, it was laid without any attempt whatever to keep it water-tight or air-tight. It was nothing but an iron trough in two halves, and they made the absurd attempt to keep it air-tight by putting putty along the edges. When the cables were put in there, I saw a good many being put in, and in some of the cases where lead cables were used the ends of the cable were simply stripped for two inches of the lead, the ends twisted together, and three or four turns of kerite tape put around it; yet that has been cited as a dismal failure of underground wire. Now I am not by any means arguing that all wires must go underground, for the simple reason that companies that have spent an amount of money and have large vested interests in coal lines and wires and business, cannot be compelled, by any equity, to remove the whole of that property and put it underground, In a great many cases it would be equivalent to sending the company out of business. But I do think that companies should endeavor, in the central parts of cities, where the streets are crowded, and the buildings are high, and there is no doubt that the overhead wires are a nuisance, that they should make an honest endeavor to put them underground. With first-class work I see no reason why underground wires should not be successful.

The question is not whether underground wires are feasible or not, but whether we cannot get them established with about the same trouble we took to get our overhead

lines in position. I am interested in a company in Philadelphia which is running the underground system entirely. We started with a 200 volt direct current system. We knew that if we started that company the wires would have to be underground, that there were no more overhead ordinances going to be passed. We realized what we were attempting, and we resolved to spare no expense to do the thing properly. When we purchased our cables from the company—they were all lead covered cables—we told that company to send us their most experienced men for the splicing and laying of those cables. We paid their expenses cheerfully. We not only had them make the joints, but we watched them. We started at the station and turned the current into those lines. We ran there for six months without a trace of leakage, and then we changed over to the alternating system. We put a thousand volts into those cables, and they are running to-day, and have been for nine months, without a single ground having occurred on them. We have fifteen miles of cable buried, all told. We have had the question before us as to whether it would not be possible to run the alternating current in the same box with telephone and telegraph cables. At the request of Chief Walker, the City Electrician, we ran in the Long Distance Telegraph Company's conduit 1,500 feet of 3-conductor cable. On the two outer wires we put our alternating current, and we placed a twenty light converter in the chief's office. Into the third wire we connected his telephone, and there is not a trace of interference on it. The telephone company, of course, had given Chief Walker permission to put that cable in their box, but they were a little nervous about the result, being afraid it would knock out their whole system between Philadelphia and New York. After we had been running about a week they came to us and wanted to know when we were going to start up. We told them that we had been running about a week, at which they were very greatly surprised, and they have made no objection to the occupation of the box by us. Of course I have had no real experience with arc lights underground, that is, high tension currents—beyond the fact that when I put down my lead cables in Pittsburgh I use a sixty-five light Brush machine to test them with. I would not, when testing them, subject them to the strain of opening the circuit suddenly upon them. I do not think it would be policy to do so. Chief Walker in Philadelphia is running some four or five miles of lead covered cable on his arc circuits. He has had one or two burn-outs. He had too strong an air line for one section, because he could not dig up the streets, being winter. But he did not expect to put down a perfect job the first time. There is one thing I would like to ask some questions on. It has been stated that a direct current arc light cannot go underground. I do not think that the gentlemen who make that statement fully realize what a tremendous weapon they are putting in the hands of the press against them. I am not speaking now as an alternating current man, but as a member of the association, and as representing a lighting company which is interested in overhead wires in so far as they do not interfere seriously with public safety. We have proved beyond any question that the alternating current can be put underground and can be put in lead covered cables without any danger of loss of current. If the direct wires cannot go underground, the alternating can. And it may be that we shall be called upon to put in new apparatus which we do not want, simply because it cannot go underground. I think that in a case of this kind it is not the technical press we have to consider; they can realize the difficulty and danger and troubles of going underground. But it is the public press we have to consider. While they certainly do not always express public opinion, they have a good deal with moulding it, and a persistent attack by the press on a lighting company will compel it to do what they desire. I think the sooner this question of underground wire is placed fairly the better it will be for all of us. I have had a good deal of consultations at various times with Chief Walker in Philadelphia, and he made the statement to me that some eighteen months ago, before he would recommend the city to spend any money in the experiment, he wished to make a test of certain cable, and he got a length of three hundred feet of cable. This was cut into two parts, and placed on the two poles—one on each pole of a Brush sixty-five light dynamo, laid in the yard of the station with the mud and water all around, and then connected with the air line. After they had run a few days a fault was developed in the cable and there was found to be a hole punched right through the insulation. I am not sure, but I think the other connection was found at the end of the wire where it was bared to attach to the air line. The defective part was cut out and he has it in his office, and as I was under the impression that he had been using that wire in that way ever since, I telegraphed him this morning as follows: "Is the 300 feet of cable originally laid in the yard still in daily operation?" I received the answer from him: "To the best of my knowledge it is;" and I will ask Mr. Law whether that is the case or not.

MR. LAW: That cable has not been in use for the last five months at least.

MR. SMITH: Very good. Then Chief Walker is mistaken. But at the same time he laid a good deal of cable in the upper part of the town, and that cable is still in use. Now the statement has been made that in Chicago the average capacity of the machines was forty-five lights, and the average circuits twenty lights. I do not know—but I think the man in charge of the station has shown poor judgment in dividing his circuits.

MR. SUNNY: If you will allow me, I will explain that in one word; we have put out more circuits than the present business requires.

MR. SMITH: Exactly. I presume that you have done as I have done in Pittsburgh. I have kept all my circuits the size of my smallest unit. But the fact that the circuits and machines do not agree is no proof that it was done because the wire was defective. I would like to call on Mr. Wilber, of the Jenney Company, who has laid a good deal of cable in Philadelphia; I would like to ask him if his cable is in use, and I would also like to ask Mr. Gwilliam to give his experience.

MR. WILBER: I would say for the information of this association that last spring we laid over two miles of underground cable in Philadelphia in the grounds of Girard College. We are running forty-seven lights on two twenty-five light machines. We have never experienced a particle of trouble with the cable, from the time it was laid up to date. Where the cables came out at the top and connected with overhead wires there have been one or two grounds and leaks and lightning troubles, but no serious defect of the cable. But I am glad to think from our experience there that there is some small grain of truth in the claim made that, you cannot get as great a number of lights out of a given dynamo capacity in running underground as you can on overhead wires. With that exception I do not know that there is any serious difficulty in running arc light currents underground, unless it be that of expense, which is sometimes prohibitory.

MR. LEGGETT: How long is the longest conduit that you have in the Girard College grounds?

MR. WILBER: It is all one circuit, sir. It is about two miles and an eighth I should judge. I do not remember the exact length. It is all one circuit, burning forty-seven lights on it.

MR. LEGGETT: You go out and come back through the same conduit?

MR. WILBER: Yes, sir, side by side. It is the standard cable laid in creosoted boxes, side by side. They come back in the same box.

MR. LEGGETT: Something less than a mile in length?

MR. WILBER: The main circuit is about a mile in length. They loop out to the different towers and different places where we have lights.

MR. LAW: I would like to ask Mr. Wilber if those conduits do not pass through passage ways that go from one building to another, and if they are not keeped out to a very high degree of temperature.

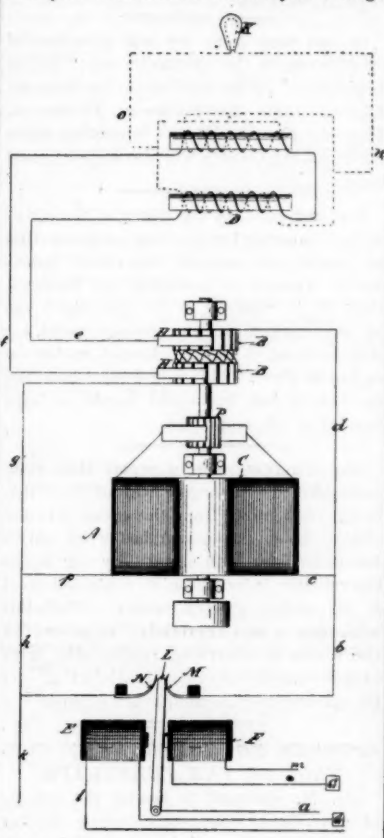
MR. WILBER: I neglected to state—and it is a very important matter—the buildings of Girard College are heated by steam, and these steam pipes are carried through a brick conduit. We got the benefit of those brick conduits as far as they went from the engine room at the lower end of the grounds up to the furthest end of the building. We ran through this brick conduit, laid our wires in boxes in the conduit, and then branched out to the towers underground—laying it simply underground; and the duct is always heated in winter up to a very high temperature and in summer it is not equally warm, because they have a circulation of air by fans, etc., to keep up a circulation of air through the tunnel. But I do not think there is any great amount of dampness in there.

THE PRESIDENT: How much of your circuit runs in the duct?

MR. WILBER: Perhaps from $\frac{2}{3}$ to $\frac{3}{4}$ of the entire circuit runs in this brick duct. Those branches cut to the towers run through the ground.

MR. KINSMAN: There is one thing that has not been referred to in connection with this underground matter, which seems to give a great deal of trouble; that is, static induction, atmospheric electricity. I would like to have some one give his experience on that.

MR. DECAMP: Two papers have been read to-day on this subject of underground conductors—one for, and the other against; but there is one thing in which they both agree, perhaps two, but one in particular, and that is that we must have a perfect insulation. The second is that it is only a matter of cost. Now I believe that the first one is true, and no station will be operating a complete underground system until they secure that perfect insulation. In regard to the point that it is a question of cost, I think that ought to be left out until some gentleman is prepared to say just what that cost will be—not that it is only a matter of cost; that is keeping the companies from doing it, even keeping them from making a fair, proper and unbiased test. The question of cost is certainly one of very great importance. Electric lighting from central stations is now nine years old. There are organizations who have back of them probably as good business talent as ever backed up any new enterprise, and as a rule they have been organized for business purposes. They are officered and controlled by men who do not hesitate to invest their money in things that they think will ultimately pay—not to get their money back, because if that is the case, they have been, without exception, I guess, grievously disappointed. They are waiting for their dividends yet. All know—if they do not they can find out very easily—that the returns upon the capital invested in electric lighting have not been large. They have not been such that would justify the investment of money in a business which is likely to undergo



SYSTEM OF ELECTRICAL CONVERSION.—SEE PAGE 8.

rapid changes or rapid improvements, carrying with them a large depreciation in the value of their property. But the business which they are doing to-day is established—the prices are established upon the basis of their cost of their present plants, and it is unnecessary to say that it would be utterly impossible for any company to go before the public to day and advance the price of their lights. The prices of electric lights are high; they always have been; they are high to-day. They are lower than they were when they started. but they are high to-day; and that is the view that every consumer takes of its Therefore you cannot advance your price.

We were running 125 arc lights from a certain station, and we needed the income from them. After the last explosion, notwithstanding the fact that Mr. Smith thought that the system of ventilating that conduit by a blower was a safe one, we had this last explosion—fortunately the first one that ever did any damage to an extent that we had a claim brought against us; and after giving the thing proper consideration, I came to the conclusion that the company could not afford to run that station and take the risk of having to pay such damages either to property or to life, and we abandoned it and have converted it into a small incandescent station. Now, in that station we are using a current of 120 volts, I think, and it is true with that current we have had no trouble. Our circuits are short, and we have put in the best wire we know how. In regard to the other explosions which have occurred in there, there were seven of them, arising out of the leakage of illuminating gas—I believe it is generally admitted by the committee appointed by the University to investigate it, that it was illuminating gas and not an admixture of illuminating and sewer gas, and that the explosion was caused by the short circuiting of the wire. Mr. Smith has had some bad wire in there, and he has had some very good wire in there. Now, here is another thing that we ought not to overlook—that the prices will not be increased at least, and that there is a much greater prospect of having to decrease them. With the scale of expenses brought as low as we have been able to bring them, and with six or seven years' experience to reveal to us our defects and deficiencies in administration, we start out to increase the cost of our construction without being able to get any compensation for it. The only offset that we have got to that is to save in the mileage of our wire, and it is just exactly what Mr. Smith is doing in making his circuits out to correspond to the smallest machine. Now, we will double up our circuits and we will double up our machines, or we will make our circuits longer and double our voltage. That is the only one offset that I can see to compensate us for this enormous increase in expense. We have not only got to provide for that 2,500 or 3,000 volts which we are using now, but we have got to provide for double or treble that, and I am sure that if this was an experiment which would cost a trifling sum, that would be one thing, but here is an experiment you cannot make except at a very great cost. I have had correspondence—not knowing that Mr. Leggett had had correspondence to the same purpose—and the statements that I got are almost identical with his own.

MR. T. C. SMITH: In speaking of the conduit on Chestnut street, I was perfectly aware of the circumstances under which the Brush Company took hold of that conduit—that it was work put down before they got hold of it. Mr. DeCamp did not make it quite clear—he seemed to think that I did not consider Mr. Walter F. Smith a competent man. My best answer is that I am using the apparatus which he uses, for putting in the conduits here in Pittsburgh. I think it is because a reliable and conscientious man did the work that your incandescent lights are running as satisfactorily as they are. If the work that he has done on the low tension cables had been no better than the work done on the old cables they would have given you the same trouble. I do not think two or three burn-outs on the first cable ever laid has anything to do with the question of success of underground conduits. It is purely a question of policy for the companies. I do not believe there is a company that has a system of overhead wiring that could put a whole system underground without going into bankruptcy. The main question is, can they not make some endeavor to put the central part of their wiring—in the central part of the city—underground, and by and by I think that they will cut off a great deal of this public opposition to their wires. In Philadelphia ordinances have been passed allowing overhead wires to be put in the suburbs, but on the main graded streets of the city I think the electric light companies will find their best policy to put some of their wires underground.

MR. WRIGHT: As representing a company which operates an alternating system, conveying it underground, I would like to make one or two remarks. It seems to me that the matter of underground work has got to be considered. The public will force us to face it. We do not intend to stand just where we are in electric lighting. Electric lighting has come not only to stay, but to increase, and if we wish to do a larger business we have got to do a general business, and in a general business we will be compelled to place our wire underground, I think. However, I will simply state to you, gentlemen, that I have now been operating for some time an underground system. It is not very extensive, and it has not been operating for a great length of time—some four months, but during that period, and possibly during the worst part of the year—during the fall of the year, when we are troubled with water in our conduits and manholes, we have had no trouble whatever in that conduit, and the only occasions on which I have had to open manholes, for the purpose of getting to my conduit, were due to outside causes. Our buildings are connected directly at the manholes and junction boxes, and on two occasions, when my men were connecting converters, they short-circuited and blew out the safety fuse, and on those occasions only we opened the conduit. When I left Springfield we had fifteen inches of packed snow on the streets. Our company do not pretend that they were doing a big thing in doing the underground work. It was simply because they were compelled to. We have no poles there. All our arc wires are on structures on the buildings. It was impossible for us to do any work there unless we went underground. I think it will be found in the next year or two that a very large number of companies in this company will be placed in exactly the same position, and that being so we must all look to the future, and try and learn all we can about underground work. My advice to our company would have been to wait and let other people experiment, had we not been compelled to go underground. However, we are running underground. The work is not costing a great deal of money, and I do not expect that we will have a great deal of trouble. I simply state that we are doing this as a proof that it can be done, for a short time at all events, and if it can be done for a short time it can be done for a long time.

THE CHAIRMAN: You say you have no arc light lines underground?

(*Continued on Page 8.*)

ELECTRICAL REVIEW

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CONTENTS.

	PAGE
Western Electric Co.'s Electric Current Indicator	1
The Bentley-Knight System at Allegheny, Pennsylvania	1
Electricity and Dentistry	1
Business Transacted at the Electric Light Convention	1, 2, 3, 4, 5, 7, 8
Leather Belting. By Chas. Schieren	2, 3
The Underground Question	4, 5, 8
A Successful Convention	6
Opposed to Government Control of the Telegraph	6
Electrical Conventionalities	6, 7
Electric Light Roster	7
The Officers for 1888	7
Electrical Converter	8
Our Boston Letter	8
Electric Motors	9
Curative Electricity	9
Electric Light News	9
Underground Conductors for Electric Currents. By Jesse M. Smith	10
Government Telegraphy	10
Electrical Street Railways	10, 11
New Telephone Work in Chicago	11
Telephonic News	11
The Distribution of Electricity by Alternate Currents. By T. Carpenter Smith	12, 13
Patchogue for Electrical Lighting	13
The Thomson-Houston Plant, Lynn, Mass	13
What Constitutes a Good Carbon Point. By J. W. Parker	14
Mr. Gaslight and his Son Bill	14
The Relation of Electric Lighting to Fire Insurance. By S. E. Barker	14, 15
How Can We Protect Our Watches Against the Influence of Magnetism? By Philip Lange	15
Discussions on Independent Engines. By Wm. Lee Church	16
Additional Convention Notes	16

In placing Dr. Otto A. Moses at the head of the executive committee, the association has acted wisely. This talented gentleman has ever been found capable and willing, and we expect to see the New York meeting under his management made the most interesting and instructive electrical gathering that ever assembled in this country.

The one danger to high-speed engines arises from the possibility of charging the cylinder with water which cannot be conveniently enough relieved through a valve at the speed at which the piston travels. The fact that no engineer justly entitled to the name should ever allow an accident of this nature to happen, does not in the public mind shift the responsibility from the maker of the engine. Spring relief valves have now been brought to a state of perfection which leaves little to be desired, when the engine is of a type permitting their use.

President Duncan had a triumphal week of it. First he was on Tuesday elected to City Council from an important district of Pittsburgh; second, he was elected an honorary member of the M.O.E.K.'s by the few surviving members of that sprout of the Philadelphia Exposition, and finally he was chosen standard bearer of the National Electric Light Association. Yet his burdens sat lightly upon him, and his face was the face of serene satisfaction. He has a keen blue eye that means business, and he will, if we mistake not, show a strong and firm guiding hand to the association, and lead its affairs rapidly onward.

The towboats on the Western rivers have regular fog-horns for whistles, and the pilots blow them almost incessantly, and the Electric Light Convention experienced some annoyance from them. But they contributed their share of fun, too. During the closing hours the retiring president called for the ayes on a question, and received a unanimous response which left an expectancy of nothing from the opposition. He then called for the nays, and instantly came the sonorous prolonged "No-o-o-o" from a passing boat that made the windows rattle, and brought a look of consternation to the "ayes," a pose of Ajax defying the lightning on the part of the herculean chairman, and a general roar from the convention.

There were over thirty columns in the REVIEW last week devoted to the proceedings of the Electric Light Convention which occurred Tuesday, Wednesday, and Thursday of that week. As Mr. Greeley would say, it made "mighty interesting reading"—last week.

Success to you, President Samuel Adelphi Duncan.

The Electric Light Convention did its work well.

Here's to you, James Frank Morrison: May all your future work be as full-crowned with high honors as are your three years' work as president of the National Electric Light Association!

In our next issue we will give special prominence to the discussion on "Patent Legislation" by the members of the National Electric Light Association at Pittsburgh, February 22. Mr. Edson's interesting paper on Recording Gauges will also appear in that issue.

It is suggested, in the matter of the use of storage batteries for street car purposes, that an independent motor or battery car be provided. Instead of removing the batteries, they can be charged in the car, which can be side-tracked, at the proper point, for that purpose, a freshly charged motor car taking its place. This would save handling the battery jars, but would require a large number of idle motor cars.

The REVIEW, with a report that comprehended the important work of the Pittsburgh convention from the opening to the closing hour, was issued last week only a few hours later than usual. By this means the valuable information it contained went to its readers a week earlier. That this achievement was appreciated is proven by the scores of observing readers who have expressed their surprise and satisfaction over the splendid work accomplished so promptly.

OPPOSED TO GOVERNMENT CONTROL OF THE TELEGRAPH.

Mr. M. Halstead is against the scheme of government telegraphy whose leading proposition, he says, is to tax fifty-nine millions of the people of the United States for the benefit of the sixtieth million; in short, to tax productive industry for the help of gamblers, slugging rings and pool room sharps of every degree. In an article in the last *North American Review* he says that, following this step, would come the absorption of the telephone and street car, the newspapers, steamboats and flouring mills in short order. He goes further and asserts that if this line of reformation is to prevail, it is only a question of time when permits with stamps on them will be required of the farmers before it shall be lawful to plant corn.

A SUCCESSFUL CONVENTION.

Now that we can look back and dispassionately review the proceedings of the late Electric Light Convention, our words of last week are fully verified in regard to the success of the meeting. It outshone previous conventions in number and importance of papers read and scientific treatment of the various subjects, and the papers were of more than ordinary interest and instructiveness. One delegate voiced the general sentiment of good accomplished by stating after the discussion of one of the papers, "I have received exactly the information I came here to get." A general feeling of satisfaction pervaded the minds of the delegates.

The officers elected promise to make the future of the association even more brilliant and successful than its past. The new president is heart and soul with the spirit of progress, and has the advantage of the personal friendship and experience of Ex-President Morrison, and we look to President Duncan for a vigorous replanting of the good seed sown and several times prosperously harvested under the watchful care of Mr. Morrison.

ELECTRICAL CONVENTIONALITIES.

JOTS OF MORE OR LESS FROZEN TRUTH ABOUT THE PITTSBURGH ELECTRIC LIGHT CONVENTION—DINNER TO THE EX-PRESIDENT AND THE PRESENT PRESIDENT.

The versatile and ever genial Slattery was welcomed everywhere. He is one of the most interesting and promising members of the electric lighting fraternity.

Mr. Henry Hine, of the parent United States Company, New York, was an observant attendant on the convention proceedings, and took particular interest in the valuable paper by Mr. O. B. Shallenberger.

Mr. W. A. Jackson, the financial head of the Detroit Electrical Works, was in Pittsburgh, and visited the convention. He is interested in the Fisher Electrical Railway which is being installed in Pittsburgh.

W. A. Kreidler, editor of the *Western Electrician*, came in with the Chicago delegation, and as newspaper men always do, acted as the guide and counsellor for the party, and saw that proper dignity was preserved.

Col. Geo. L. Beetle, representing the Western Electric Company, was at Pittsburgh early, and on that account was forgiven for missing the Boston Convention. No convention seems complete with the genial colonel away.

Mr. R.W. Blackwell, of the Bentley-Knight Company, found time to run in to the convention from the successful electrical railway his company has put in in Alleghany, and receive a warm greeting from his New York and other electrical friends.

Frank Ridlon was so well satisfied with one trip between New York and Pittsburgh with the jolly electrical men, that instead of returning with them, he went to Chicago from the convention. He said one trip like that a week was all his constitution could stand

M. A. Knapp, of Chicago, whose resemblance to a Spanish nobleman was generally remarked, renewed his acquaintance with many electrical friends who had not seen him since the first meeting of the association in Chicago, three years ago. Mr. W. H. McKinlock, of the same city, came also, and was warmly greeted.

Mr. Jarvis B. Edson's paper on Recording Gauges was attentively followed, and all regretted that lack of time prevented more lengthy discussion. Mr. Edson met many new and old friends at the convention, and was often interviewed by the practical electric light men—and their number was great—who were seeking information.

One of the ablest members of the association is Mr. Jesse M. Smith, of Detroit. A gentleman of high scientific attainment, a ripe scholar, whose knowledge has been increased by much research and study in foreign countries, his work in the electrical field must surely be most valuable. He is a gentleman the association can well afford to hear from often.

"The doctor is always ready," remarked President Morrison to a REVIEWITE, when Dr. Moses had quickly rejoined, upon being asked to prove that the statement of Mr. Rice, jr., that the alternating current ran from zero to 2,000 volts was only an hypothesis, that he "stood as Faraday said one always should stand in front of an hypothesis—with a suspended judgment."

There were a number of very pleasant dinners given in the evenings, after the day's work was done. Dr. Otto A. Moses entertained, as only he can, a party of friends Wednesday evening at the Hotel Duquesne, and the same evening, at a later hour, Mr. R. T. McDonald pleasantly entertained a chosen few at the Hotel Anderson, at which the sparkling wit of Marmaduke M. M. Slattery, as toastmaster, with the responses it provoked, made the hours pass unnoticed and unnumbered.

The titles of "doctor," "professor," and even "your honor"—the last, by W. W. Leggett to the president, bringing down the house—were heard often. Finally Mr. Leggett, who had been called "doctor" several times, protested, stating that he had a brother who claimed that title, and E. W. Rice, jr., made similar protest against being called "professor," and A. V. Garratt was getting on his feet to make objection to being called both "professor" and "doctor," as were several others, when Dr. Moses got the floor for a different purpose, and was greeted by the president with "*Doctor* Moses." The laughter that followed was redoubled when the doctor aptly responded, "*Mr.* President." From that time on the titles were chiefly "colonel" and "general."

Secretary Harding, of the association, is a prominent singer of the city of Baltimore, the leader of one of the fine choirs there.

The new executive committee went promptly to work and held its first meeting immediately upon the adjournment of the convention.

The wire table distributed at the convention by the Bridgeport Brass Company, through its able author, H. D. Stanley, was sought for by every one.

Gen. C. H. Barney, of the Sawyer-Man Company, a former well-known telephone man, is thoroughly at home with his new duties as an electric light man.

G. Washington Davenport, of Boston, was finally awarded the banner for good looks. And like his honored namesake, he has a very well earned reputation for vermouth and voracity.

Samuel H. Taylor, of San Francisco, made the longest trip of any delegate, and he felt amply repaid. All that he objected to was that he couldn't get more votes for San Francisco as the next meeting place.

President Metzgar, of the National Telephone Exchange Association, whose home is in Pittsburgh, was a convention visitor. He kindly presented the convention the service of a telephone set during its sessions.

Vice-President Dustin and Gen. Supt. Dalzell, of the Schuyler Electric Co., were prominent attendants and observers. It is evident that the Schuyler system will be heard from most conspicuously hereafter.

No more popular or capable representatives of allied interests attend the Electric Light conventions than Messrs. Willard L. Candee and Geo. T. Manson, of the Okonite Company. And in the same category must be placed H. D. Stanley, of the Bridgeport Brass Company.

A number of the Eastern delegates remained over Friday and visited the extensive glass factory of the Phœnix Glass Company, under the guidance of A. H. Patterson. Besides receiving a treat in seeing the workings of this great establishment, each visitor was privileged to carry away with him a unique glass design called "Jacob's ladder," made before his eyes.

"Lacerated" is a word fraught with ominous meaning, and proved an "open sesame" to the commissary department, after it had been closed, on the special train that took the New York and Boston delegation to Pittsburgh. The man with the "lacerated" hand was found to be doing quite well the next morning, owing, no doubt, to the efficiency of the commissary.

Col. Glazier, the genial Chicago end of the Jarvis Engineering Company, is never found lacking in hospitality. A companionable lunch was given by him on Thursday to his friends of the electrical press. Garratt, of the *Modern Light and Heat*, Kreidler, of the *Western Electrician*, Price, of the ELECTRICAL REVIEW, and Mr. S. A. Duncan and Mr. J. A. Pentz were the partakers of the Colonel's good cheer.

At the theater where the "Little Tycoon" was on the boards:

"What are these—Idiots?"
"No Electricians!"

And in the topical song:

"They would make us believe they're electricians,
"But they can't do it, you know, they can't do it, you know."

Mr. E. L. Babcock, of 39 Park place, N. Y., exhibited his new and powerful clutch pulley in the hotel corridor, where it was examined quite generally.

A. H. Patterson, the "Phœnix," acted as ballast for the special train from New York, and through his persuasive efforts the passengers were all privileged to retire early and enjoy a night's repose undisturbed

"THE KING IS DEAD"—"LONG LIVE THE KING."

The above was the first toast at the superb little dinner party at the Hotel Duquesne, given Thursday evening by that able and rising young electrician, Mr. Morris W. Mead, Chief of the Electrical Department of Pittsburgh, in honor of the past and present presidents of the Electric Light Association and a few friends. No more perfect meal was ever served in Pittsburgh, and Mr. Schlosser, of the hotel, well merits this brief recognition of his splendid treatment of his electrical guests

In an informal manner, at the close of a dinner in which the sparkle of repartee between the participants had added zest to the refreshments—and in which honors were easy between Slattery of Indiana and Baker of New Jersey—toasts were proposed and responded to in a charmingly frank and cheerful spirit. Mr. Morrison, ex-president, spoke feelingly of the many courtesies extended to him during the past three years, as presiding officer, and stated, now that the election was over and his successor unanimously chosen, he would only say that, of all men, the convention's choice had been the one he would have made as the best fitted to carry onward towards its full fruition the mission of the Electric Light Association Kind words were spoken for the earnest supporters of the association, both present and in distant cities, and a high compliment was paid the Electric Club of New York for the considerate offer of the privileges of the club house during the next convention.

MR. S. A. DUNCAN, the newly-elected president, in response to a standing toast, delighted his listeners with eloquent words of appreciation of the honor conferred. He pictured a bright future for the Electric Light Association, that could not fail to fill with pride the hearts of the earnest pioneers in the cause, and expressed in a manner that left no doubt of the intense sincerity of the speaker, his determination to be found worthy of the high honor and great work that had fallen to him in the present election.

Numerous other toasts were responded to, all in the happy conversational manner that kept every one at his ease. Mr. Mead, in the most charming manner spoke of the great strength that had come to the electrical fraternity, largely through the friction of bright minds at these conventions, and paid the highest compliment yet given President Duncan, coming from one who had known him long as a neighbor, and a co-worker for the advancement of the practical application of electricity. He stated, as evidence of the high standing of Mr. Duncan in Pittsburgh, the fact that he had been elected by a majority over all candidates, on Wednesday of that week, to the city council, in a newly-districted ward where the political majority was 400 against him, and where there were other candidates in his own as well as other parties. His candidacy had been thought impossible of success, yet his neighbors had rallied to his support, and given him a most gratifying endorsement,

This statement created a sensation among the friends of Mr. Duncan present, and he was loudly cheered much to his evident embarrassment. Mr. Morrison, acting as toastmaster, called on Capt. Candee to respond to the Electric Club of New York, stating that his personal wish for the success of the club was far beyond what its founders ever dreamed of securing for it. Captain Candee was equal to the kindly preface thus given, and responded eloquently and in happy taste. Mr. Baker of Newark, in a few bright words, Mr. Patterson, of New York, with his ever ready wit, Mr. Slattery, never more happily, Mr. Ross, of Boston, Mr. Price, of New York, Mr. Baxter, of Pittsburgh, Mr. McDonald, Mr. DeCamp and Mr. Ridlon responded to toasts, and at eleven o'clock, when the dinner party separated, there was a feeling on the part of all that they had enjoyed one of the most delightful evenings of their electrical life, in which friendships had been cemented, and acquaintanceship had ripened into an affection that would prove lasting and sincere.

Those present were S. A. Duncan, Morris W. Meade and Mr. Baxter, of Pittsburgh; Mr. Morrison and Mr. Tudor, of Baltimore; Messrs. Candee, Patterson, Price, and Manson, of New York; Messrs. Ridlon and Ross, of Boston; Messrs. DeCamp and Porter, of Philadelphia; Mr. Baker, of Newark; Mr. Royce, of Washington, Messrs. McDonald, Slattery, MacKie, of Ft. Wayne; Mr. Cooke, of Cleveland, Mr. Ogden, editor Pittsburgh *Post*.

ELECTRIC LIGHT ROSTER.

ALPHABETICAL LIST OF COMPANIES REPRESENTED AT THE PITTSBURGH CONVENTION, AND NAMES OF ATTENDANTS.

A.

Allegheny County Light Co., Pittsburgh—Robt McGonnigle, secretary; T. Carpenter Smith, superintendent; Samuel A. Duncan, F. B. Roney.
American Waltham Watch Co., Boston—H. E. Duncan.
American Electrical Works, Providence—P. C. Ackerman, New York.
Armington & Sims Co., Providence, R. I.—J. F. Randall, Cleveland, O.
Austin Water Light and Power Co.—M. D. Mather, Austin, Texas.
American Leather Link Belt Co., New York—Chas. A. Schieren; G. H. Fisher.
Ansonia Brass and Copper Co., New York—Frank G. Stone.

B.

Baker & Co. (platinum), Newark, N. J.—C. O. Baker, jr.
Benedict & Burnham M'f'g Co, Waterbury, Ct—Geo. G. Blakeslee.
Bernstein Electric Light M'f'g Co., Boston—Henry B. Cram, treasurer and general manager.
Bigelow M'f'g Co., New Haven, Ct.—F. L. Bigelow.
Brush Electric Co., Baltimore, Md.—J. F. Morrison.
Brooks Underground Telegraph Co., Philadelphia—David Brooks.
Bradley Electric Power Co., New York—C. S. Bradley.
Brush Electric Co., Cleveland, Ohio—C. C. Curtis, S. M. Hamill, jr., Cleveland; W. F Swift, New York.
Brush Electric Light Co., Rochester, N. Y.—Geo. A. Redman.
Brush Electric Light and Power Co., Cleveland, O.—H. C. Cooke.
Brush Electric Light Co., Buffalo, N. Y.—C. R. Huntley, secretary and general manager; J. C. Weber, superintendent; H. H. Humphrey.
Brush Electric Light Co., Philadelphia—A. J. DeCamp, M. D. Law.
Boston Electric Protection Association, Boston—Geo. W. Adams
Bridgeport Electric Light Co., Bridgeport, Ct.—H. D. Stanley, J. M. Orford.
Brush Electric Light Co., Detroit—Wells W. Leggett.
Baxter Motor Co., Baltimore—J. F. Morrison, manager; W. H. Harding, secretary, Baltimore; Norman McCarty, Brooklyn; Frank Ridlon, Boston.
Bentley-Knight Electric Railway Co., New York.—R. W. Blackwell.
Brush Electric Co., Pomeroy, O.—E. S. Trussell.

C.

Central District and Printing Telegraph Co, Pittsburgh—Henry Metzgar, W. G. Hohmann.
C. & C. Electric Motor Co, New York—H. L. Lufkin, Geo. W. La Rue.
Citizens' Electric Ill. Co., Brooklyn, N. Y.—E. F. Peck, superintendent.
Callender Insulating & Water-Proofing Co., New York—W. M. Callender and A. W. Butterworth.
Campbell Electrical Supply Co., Boston—Frank E. Clark, Boston; C. I. Hague, New York.
Central Electric Co., Chicago—Wm. H. McKinlock.
Cuyahoga Falls M'f'g Co, Cuyahoga Ohio.—E. L. Babcock, New York.
Council Bluffs Electric Light Co., Iowa—Thos. Officer.

D.

Danbury Electric Light Co.—E. Wightman, Danbury, Conn.
Detroit Electrical Works.—W. A. Jackson.

E.

Edson Pressure Recorder.—Jarvis B. Edson, New York.
Electrical Supply Co.—Fred. De Sand, Chicago, Ill.
Eastern Electric Cable Co.—H. H. Eustis, Boston.
Edgerton Electric Motor Co.—N. H. Edgerton, Philadelphia, Pa.
Eddy Electric M'f'g Co., Hartford.—A. D. Newton, M. E Baird.
Electric Construction & Supply Co., New York.—F. E. Kinsman.
Excelsior Electric Co.—F. W. Horne, Chicago.
Elizabeth, Morristown & Passaic Electric Light Co.—Henry W. Pope, Elizabeth, N. J., president; James E. Brown, secretary.
Electric Co. of Va., Norfolk.—Jas. L. Belote, superintendent.
Edison United M'f'g Co., New York.—W. A. Giles.
Electric Light & Power Co., Steubenville, Ohio.—J. F. Flood.
Electric Gas Lighting Co., Boston.—Louis W. Burnham.
ELECTRICAL REVIEW, New York.—Chas. W. Price, T. J. McTighe.
Easton Electric Light Co., Easton, Md.—Chas T. Wrightson, secretary.
Electrical Engineer, N. Y.—Geo. M. Phelps, jr.
Electric Car Co. of America, Phila.—A. Reckenzaun, London.
Electric Light & Power Co, Carbondale, Pa.—Jno. W. Aitken.

F.

Ft. Wayne Jenney Electric Light Co., Ft. Wayne, Ind.—R. T. McDonald, M. M. Slattery, Rob. Mackie, W. W. Simons, Ft. Wayne; W. J. Buckley, Chicago; G. A. Wilbur, Philadelphia.
Faraday Carbon Co., Pittsburgh.—D. D. Dickey, J. F. Armstrong, Pittsburgh; Geo. F. Porter, Philadelphia.
Forest City Electric Works, Cleveland.—W. B. Cleveland.
Frisbie & Co. (Clutch Pulleys). – New Haven.—Wm. M. Frisbie.

G.

Greeley & Co., The E. S., New York—F. A. Magee.
Globe Carbon Co., Cleveland—M. A. Davitt.
Gleason Mfg. Co., E. P., New York—Wm. F. Cullen.
Gas and Electric Co., Binghamton, N. Y.—John Anderson.
Geneva Non-Magnetic Watch Co., New York—Addison Conkling and Robt. S. Hubbell.
Giles Anti-Magnetic Shield Co., Chicago—C. K. Giles.

H.

Hill Clutch Works, Cleveland—H. M. Hill.
Holmes, Booth & Haydens, New York—J. L. Barclay, Chicago.
Hafner's Anti-Friction Drive for Dynamos, New Brighton, Pa.—John N. Hafner.
Hawkeye Electric Co., Chicago—W. M. Talcott.
Hammond Electric Light Co., Pittsburgh, Pa.—W. H. Miller.

I.

Insulated Wire, Philadelphia—Alfred F. Moore.
Indianapolis Jenny Co., Indianapolis—Brainard Rorison.

J.

Jarvis Engineering Co., Boston, Mass.—J. N. Pratt, New York.—Col. Glazier, Chicago.

K.

Kansas City Electric Light Co., Kansas City, Mo.—E. R. Weeks.
Keystone Light and Power Co., Philadelphia—Geo. T. Gwilliam.

L.

Lima Electric Light and Power Co.—J. L. Melvon, Lima, O.
Lord's Boiler Cleaning Compound—J. E. Doughty, Phila.

M.

Minnesota Brush Electric Co., Minneapolis, Minn.—S. S. Leonard.
Mendota Electric Light Co., Mendota, Ill.—L. R. Curtiss.
Modern Light and Heat, Boston—R. F. Ross, A. V. Garratt.
Morristown Electric Light, Heat and Power Co., Morristown, N. J.—Geo. E. Voorhees.
Munson & Co., Chicago—J. H. Shay.

N.

National Carbon Co., Cleveland, Ohio—W. H. Lawrence, Webb. C. Hayes, J. S. Scoville, C. D. Smith, Eli S. Sanderson.
Narragansett Electric Lighting Co., Providence, R. I.—O. B. Bird.
N.Y. Electric Construction Co.—F. G. Cartwright.
National Conduit M'f'g Co., New York—James P. McQuaide, Edward S. Perot.
Nashville Light & Power Co., Nashville, Tenn.—Jos. Wills.
North Attleboro Electric Co., North Attleboro, Mass.—L. W. Dillon.
New York Insulated Wire Co., New York—J. W. Godfrey, David H. Smith.
National Pipe Bending Co., New Haven—Simeon J. Fox, F. L Bigelow.
New York *World*—C. S. Murphy.

O.

Okonite Co., New York—W. L. Candee, Geo. T. Manson.
Ohio State University—Arthur Hartwell, Columbus, O.

P.

Phoenix Glass Co., New York—A. H. Patterson.
Plainfield Electric Light Co., Plainfield, N. J.—W. H. Moore.
Parker-Russell Mining and Manufacturing Co., St. Louis—George W. Parker, D. R. Russell.

Q.

Queen City Electric Co., Cincinnati—A. R. Foote, L. W. Davis.

R.

Royce & Marean, Washington, D. C.—Fred. W. Royce.
Railway Telegraph Supply Co., Chicago.—M. A. Knapp.
Royal Electric Co., Montreal—W. R. Kimball.
Russell Engine Co., Massillon, Ohio—C. A. Gates.
Roebling's Sons, John A., Co., Trenton, N. J.—W. E. Finck; Pittsburgh—J. C. Kay.

S.

Sprague Electric Motor Co., New York—H. McL. Harding.
Shultz Belting Co., St. Louis—J. A. J. Shultz.
Sperry Electric Co., Chicago—Elmer A. Sperry.
Standard Light and Power M'f'g Co., Montpelier, Vt.—E. D. Blackwell.
Simplex Electrical Co., Boston—A. F. Mason
Schuyler Electric Co., Middletown, Conn.—Chas. E. Dustin, vice-president; J. A. Dalzell, general superintendent.
Syracuse Electric Light and Power Co.—A. P. Seymour, superintendent.
Standard Underground Cable Co—F. E. Degenhardt, Chicago—G. L. Wiley, New York.
Solar Carbon M'f'g Co., Pittsburgh—F. B. Laughlin, Pittsburgh; C. B. Curtis, Chicago.
Standard Carbon Co.—W. H. Boulton, J. B. Crouse, Cleveland.
Sawyer-Man Electric Co., New York—C. H. Barney, New York; P. H. Alexander, Boston.
Standard Electric Time Co.—C. D. Warner, New Haven, Ct.
Southwark Foundry and Machine Co., Philadelphia, Pa.—James D. Pentz.
Swan Lamp M'f'g Co., Cleveland, Ohio—Samuel E. Cox.

T.

Thomson-Houston Electric Co., Detroit, Mich.—J. E. Lockwood, general manager.
Thomson-Houston Electric Co. (parent), Boston, Mass.—E. W. Rice, jr., Geo. Washington Davenport, W. A. Boland, A. L. Roher, Boston; T. P. Bailey, Chicago.
Thomson-Houston Carbon Co, Fremont, Ohio—W. R Caulkins.
Thomson-Houston Electric Co., Petersburg, Ind.—Chas. D. Wright.
The *Electrical World*, New York—T. C. Martin, C. E. Stump, Jos. Wetzler.
Thomson-Houston Electric Co., Janesville, Wis.—Pliny Norcross.
Thomson-Houston Electric Co., Omaha, Neb—Winot Tirrill.
Thomson-Houston Electric Co., San Francisco—Samuel H. Taylor.

U.

U. S. Electric Lighting Co., New York—Henry Hine, B. B. Nostrand, jr.
U. S. Illuminating Co., New York—E. T. Lynch, jr.
Utica Electric Light Co., Utica, N. Y.—Jas. C. DeLong.
United Electric Light Co., Springfield, Mass.—Alex. P. Wright.
U. S. Electric Light Co., Philadelphia, Pa.—Lewis R. Schultz.
Union Electric Co., Pittsburgh, Pa—H. G. Bauman, manager.

W.

Westinghouse, Church, Kerr & Co., New York—Walter C Kerr, Isaac H. Davis, New York; H. E. Longwell, Chicago.
Wyckoff Pipe Co., Williamsport—Frank O. Wyckoff.
Western Electric Co.—Geo. L. Beetle, John Young, Chicago.
Wainwright M'f'g Co., Boston—C. D. Wainwright, Boston, Mass.
Westinghouse Electric Co.—H. M. Byllesby, F. S. Smith, Frank H. Cole, Pittsburgh, Pa; F. H. Tidnam, Philadelphia, Pa.
Western University of Pennsylvania, Pittsburgh, Pa.—A. E Frost.
Washburn & Moen M'f'g Co, New York—Richard C. Smith.
Westinghouse Lamp Factory—A. L. Reineman, superintendent.
Westinghouse Air Brake Co., Pittsburgh, Pa.—S. Howard Sprague, secretary.

Personal.

Barton, S. E., Boston, Mass.—New England Insurance Exchange.
Bliss, S E., Chicago.
Connolly, Thos., Washington, D. C.—patent attorney.
Black, H. M., Pittsburgh.
Dee, James R., Houghton, Mich.
Forbes, Prof. Geo., London, England.—Electrical Engineer.
Hayes, Harry, Newark, N. J.
Mead, Morris W., Pittsburgh, Superintendent of Bureau of Electricity.
Mix, E. W., Columbus, Ohio.
Moses, Dr. Otto A., New York, Electrical Engineer.
Sawai, Kiyoshi, Tokio, Japan—(on tour of study.)
Smith, Jesse M., Detroit, Mich., Electrical Engineer.

The Officers for 1888-9.

President—Samuel A. Duncan, Pittsburgh.
First Vice-President—E. R. Weeks, Kansas City, Mo.
Second Vice-President—A. J. DeCamp, Philadelphia.
Secretary and Treasurer—(To be appointed by the president.)
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The Underground Question.

(*Continued from Page 5.*)

MR. WRIGHT: I have one arc light line underground, but not connected.

MR. EUSTIS: I would like to ask Mr. De Camp whether there has been any trouble in Philadelphia from depression of the ground causing chafing of the cables?—a matter that has occurred to my own knowledge in underground work.

MR. DECAMP: I am very sorry that Mr. Smith is not here; he could answer that question; but I will say that I do not believe that anything of that kind has been discovered or realized to any serious extent, because I think he would have mentioned it. On the contrary, he has frequently made the statement to me that some wires which we have displaced that were occupying a convenient duct in the conduit came out, to all appearances, as good as they were when put in.

MR. EUSTIS: I would like also to bring up that other matter that has been referred to, and that is in regard to the static charge or discharge whereby the insulation of the cables is ruptured. Now in the matter of a lead-covered cable, we have there the best conditions, of course, of a condenser, that is, the inside conducting wire, the insulating material, and the outside lead covering in close connection. Now if a static charge takes place, the cable itself being a condenser, the longer it is and the better the insulation of the cable, the better the condenser, until you would get a very heavy charge, its total length. If there happens to be one weak spot in it, the whole force would be expended on breaking it at once. A number of gentlemen have spoken to me with regard to the puncturing by the discharge—that it always discharges directly through the lead. With a mass of lead around the outside, we would naturally suppose that the electricity would travel along the lead rather than directly through it, because oftentimes the lead is not in direct connection with the ground at that particular point. Now the question comes here, does it go through? Is it true that the static charge has a persistent in one particular direction rather than near the line of greater conductivity? I, for one, should like to hear from those who have had experience in that direction.

MR. LOCKWOOD: I would like to ask the gentleman who has just taken his seat, whether the result described was not brought about by the fact of the heat evolved at that point, by the connection having melted, the lead leaving a bare space not covered, and having simply given the appearance of the electricity having passed through.

MR. EUSTIS: That is a point I cannot answer. The thing was simply mentioned to me. As I understand it, however, the same thing has occurred in iron pipes where the wires were laid in a mass of insulating material; that the same rupture has taken place, forming, as it were, a very small hole directly through the iron pipe, burning it out, and at the same time that that was done, it did not seem to be due to the fact of poor insulation, so to speak, at that one particular point. It seemed to me more due to static charge. I have also heard it stated that this usually occurs where the underground system is used in connection with the overhead, not where an underground system is used exclusively.

MR. GWILLIAM: This question as to the condensation of underground cables I think can be answered. I am not an electrician; I am a civil engineer, and I have had quite a large experience in laying underground cables. We have personal supervision of all the cables laid by the Keystone Light and Power Company, of Philadelphia, and personal supervision of the making of their connections and joints. That, I think, is where the difficulty has originated in the past—bad connections. We have put down lines of double conductor cables for the alternating system that only have a covering of lead over the whole of it. They have run successfully for nine months, without the slightest trouble from them. I think, if the question of condensation occurred, it would occur in there, where the two wires were so closely together.

MR. LOCKWOOD: In regard to the conductors used by the companies doing lighting in London, while I was there during the years 1881 and 1883, I had been informed, I stated this morning, that they were twice or three times renewed, and that I thought, at that time, they were using the best cables manufactured. The cables used by the Anglo-American Brush Company, of London, were manufactured by the India Rubber and Gutta Percha Telegraph Cable Company, Limited, of London. After the first two burn-outs, I do not think it stands to reason that they would put in a third cable of an inferior quality; and if, as Prof. Forbes said, the first two cables were gutta percha, while the quality they now consider the best insulator is india rubber, I think that this firm would have put in whatever they considered the best; and my information I obtained from the president of that company, while ordering cable from him for our now company. He told me they had twice removed the other company's cables. He said, "We are now supplying a third cable to do their work, and we hope this cable will do the work." And it was to find out whether the last had successfully accomplished this result that I put the question this morning to Prof. Forbes. In regard to our work in Detroit I would say that we have there the Dorsett conduit, laid before I went to that city, and the Thomson-Houston wires. The majority of the wires—four-fifths, probably—were eighteen months ago laid in that conduit. They were the Callender wire. We had, from the outset from my connection with that company, trouble with these wires. We had them largely from single grounds. They were never absent. But I do know that grounds on circuits resulting in a partial short-circuiting of the circuit were difficulties that we had very frequently. One night, especially, I remember, before either end of the circuit entered the conduit, we had the central portion of the circuit cut out, so that the lights on that portion were simply red. The lights on the end portions, where the wires were overhead, were to their full brilliancy. We found, on investigation, that one of the troubles was water within the conduits, and that was something, I found, from which they were never free. The other trouble in this case was in one of the iron pipes leading out of the conduit to one of the buildings in which we had lights. Now we had, during my connection there, a great many troubles of that kind, and we had them so frequently that we gradually substituted aerial wires for underground wires. Our trouble now, compared with what we used to have when the wires were underground, is, comparatively speaking, nothing.

MR. SMITH, of Detroit: We have heard a great deal about the number of accidents that have occurred in underground conductors. Now if we are to condemn a system of underground conductors by the accidents, what becomes of the whole electric light system? The whole history of electric lighting, and in fact the whole history of any industry, is built up on the experience of accidents and failures. We have heard a great deal about the failures; we have not heard a great deal about the successes. We know that incandescent lights are doing good work to-day. What were they doing five years ago? What were arc lights doing five years ago? We have an arc light to-day which is steady; a man can read by it. He could not read by an arc light five years ago. We have incandescent lights to-day that will last for 1,000 hours and consume 50 watts of energy. What could we have done even a year ago in that respect? So far as any advancement is to be made in any branch of electric lighting it must be done by profiting by the good experience as well as by the bad experience of the past. Now in regard to the shunting off of the current and discharging the field magnets into the wire, that certainly throws an immense strain on any system, and the discharge of static electricity does exactly the same thing as the water hammer in water distribution. You set a faucet running and then turn it off quickly, and you have the whole system jarring and trembling, and oftentimes breaks are made in that way. There is no difficulty in overcoming it, because we have found out how to do it; so we will find how to prevent static discharges and discharges from field magnets or dynamos, from puncturing the insulation. In regard to the Girard College installation we have learned that part was put into hot conduits; part of it is laid in common wooden pipes under the ground. Sometimes it is exceedingly hot and sometimes it is cool in the summer by the circulation of air. That only proves to me, gentlemen, that the underground system is, if properly put in, able to withstand all these difficulties, and the only trouble that is cited in connection with the Girard College plant was a leakage at the joint, and there comes the question again, as I said, and I think I will not be contradicted, that 90 per cent. of all the failures that have taken place in underground conductor or any kind of conductors have been at the joints. The question has been raised about short circuits between the conductor and the lead. Certainly when the lead conductor is laid in the wet ground, the lead is a conductor and the ground is a conductor. Why is the lead any worse than the ground? The ground is generally considered a pretty good conductor. The telephone and telegraph people use it for their returns entirely, and they use it because they do not get any resistance. Therefore it is the best conductor they can get. I pretend to say that the lead casing on the outside of a thoroughly insulated conductor is no worse than a thoroughly insulated conductor laid directly in water or directly in damp ground. We have heard about the short circuits from the line to the case. I suppose some persons have heard of short circuits between telephone wires and district telegraph wires. We have heard about lead-covered cable being a failure in a great number of places. In certain places it is prohibited by the underwriters. Such cable I have seen a good deal of. I have seen quite a good deal of it where the lead casing was barely $\frac{1}{64}$ of an inch thick, and was nailed up very securely to a brick wall with double-pointed tacks. That is one way of putting it up. One way of making joints in such conductors is to strip the joints, twist the wire together and let it go at that—sometimes put a little tape on, but that is not always considered necessary. So it is with the iron casing. An iron casing is a conductor just the same as lead. The ground is just as good conductor as either of them. And I take the position that when a conductor is put into a duct, that just as good insulation could be used when it is put into the duct as if it were laid directly in the ground or directly in the water; and I also take the position that a lead covering or an iron covering or a tape covering, or whatever protection is put on the outside of the insulation, is simply put there for mechanical protection; that the insulation must be between the mechanical protection and the conductor, and must be put on in such a way that the conductor cannot eventually melt down through the insulator and come in contact with the casing. Now it seems to me that there are certainly a number of thoroughly good insulations that have been tried that won't run, if they are properly put on with textile fabrics, such as tape or braid, so that the insulation can be held on to the conductor, and then, after it is thoroughly held on and thoroughly insulated, that the whole thing shall have a casing of some kind, whether lead or iron or what not—simply a casing on the outside of all of it, that shall be a mechanical protection. This sounds like a very expensive cable. It certainly is. But is it a greater expense, for the amount of light and for the return given, than the gas mains of a large city? Do not the gas companies invest twice as much capital for the amount of lighting as is invested in any electric light station in this country?

MR. DECAMP: I do not want to go on the record as opposing the underground system to the extent of making any effort for its ultimate accomplishment. But all that Mr. Smith says, and all that people say here, comes right back to that one thing—a perfect insulation. Now that is what I claim we have not yet discovered. Where you put it underground you put it out of your reach. It is not like where you have a wire overhead where you can go right to the imperfections and correct them. I do not mean to say that we are not subject to those annoyances of grounds and crosses on overhead wire, but we can go and remove them. We cannot when our wires are underground I have understood that the amount of business to be done over a telegraph wire is limited to the number of minutes they can use that during the day.

MR. T. C. SMITH: If the alternating system had been let go because a year ago at the convention we were shown some pretty experiments to demonstrate that converters would burn out three weeks after they had been put up, there would be 100,000 less incandescent lamps in the country to-day. If we are to abandon experiments to put our wires underground, because a large number of the attempts to do so have been failures, we had better go out of the business.

MR. DECAMP: I do not recall to mind a single one of our troubles with underground wires.

MR. LAW: We never have had a joint give out.

MR. WRIGHT: Then you must have a perfect insulation around your joints.

MR. SMITH, of Detroit: I do not know but that I made the statement that the faults were directly at the joints. I think they are directly traceable to the joints. If a lead-covered casing or any other kind of a casing is brought up to the surface and simply the lead casing taken off, the insulation exposed and taken off also a little and the wire exposed and a connection made on to it to go to an aerial, and the insulation is left so that it can absorb mositure, it will gradually creep in between the insulation and the casing, and you don't know where it is going. It may go in a foot or it may go in ten or fifteen feet. The fault will come wherever the moisture strikes a flaw in the insulation. In regard to the earning proportions of a gas pipe, and earning proportions of an electric light wire, it seems to me they are entirely similar. You have got wire in one case and pipe in the other. You have got the potential in it. If you do not get it out it is your own fault.

MR. LEGGETT: In the case of pipe you can count in getting your gas. With the other, you cannot count on getting your electricity.

MR. SMITH, of Detroit: I do not see that, sir. There are faults in gas mains. You often see the streets dug up in the winter time to put a sleeve on a broken joint. I think you will find the streets dug up as many times for gas and water pipes as for electric lights, counting the same number of feet of wire of pipe.

MR. DECAMP: At the same time anybody can see the conditions will be similar when we reach a storage battery corresponding to a gas holder. There is where our trouble comes.

MR. T. C. SMITH: The best storage battery, Mr. DeCamp, is a spare dynamo.

Electrical Converter.

MR. E. N. DICKERSON, JR., is the patentee of a system of electrical conversion, illustrated on page 5. In his patent he states:

No. 377,862. System of Electrical Conversion. E N. Dickerson, jr.:

By my attachment I can take from an ordinary non-reversing high-tension current electricity which will serve to furnish a low-tension reversing current in the house or locality where it is desired to use it. I accomplish this result by combining an electrical converter of a type known as the "Westinghouse converter" with a reversing motor which controls the polarity of the main circuit, and which is located at the point where it is desired to take off the branch circuit.

A high-tension current flows out upon the circuit *a*, and returns to the generator by the circuit *k*. By the switch *L* it passes to the spring *M;* thence by the circuit *b c p h k* it passes through the motor *C*, which is operated by its own commutator *P*, in the usual manner. On the shaft of this motor is arranged the double reversing commutator *B B*, the sections of which are alternately connected, as shown, one set of sections being connected with the circuit *d* and the other with the circuit *g*. The commutator springs are made just broad enough to lap two sections, so as to prevent the breaking of the current, and these commutator springs *H H* connect with the circuits *e f*, which go to the Westinghouse converter *D*.

It is obvious that the current upon the circuits *e f* is a high-tension reversing current, and therefore will operate the converter *D*, which further converts a reversing high-tension current into a reversing low-tension current which passes out in the secondary circuit *n o*, and may be used to light the incandescent light *K*. This converter and motor are supposed to be located together, by preference without a house, and the circuit *n o* enters the house.

OUR BOSTON LETTER.

(From a special correspondent of the ELECTRICAL REVIEW.)

Col. Keller, of Newton, Mass., appears to be the pioneer in the field of electric sleigh lighting. A small storage battery placed under a seat furnishes power for two eight candle power incandescent lamps which give a very bright appearance to the sleigh. The Bristol (England) *Times and Mirror* of recent date says: "Electricity is soon to be put to a novel use. A number of wealthy gentlemen in Newton, Mass., are about to apply electricity to lighting their sleighs in winter, and at other times to their closed and open carriages.

The "Temporary Connections" sign has been removed from the wall of the Edison Illuminating Company's station, and the bright copper connecting rods, long even rows of resistance boxes and equalizers present a very neat appearance.

Mr. George W. Mansfield, well known in electric motor circles, read a very interesting paper before the mining engineers on "Electric Motors and their Applications to Mining Engineering." The discussion following was very interesting.

Some Connecticut electric light men, after reading the Edison "Red Book," say they "are very thankful to the Edison Company for so long allowing us to breathe their air and walk on their earth."

Mr. H. H. Cutler, of Newtonville, has been experimenting with an arc lamp on the secondary circuits of some transformers. He says that he thinks in a short time he will be able to place a few lamps in that manner, and he will be able to do some very nice work, as with the low tension the wiring may be concealed.

Mr. Charles L. Ireson reports increasing business. His self-adjusting link belt is certainly giving excellent results.

The Thomson-Houston Electric Company have recently taken orders for about 5,000 incandescent and over 200 arc lights in New England. Many of the incandescents are to run from their new alternating current system.

T. W. S.

Boston, Feb. 28, 1888.

The executive committee held its first session at noon Monday, and elected a number of new members and transacted a great deal of routine business. There is much more hard work connected with the management of this association than the committee gets credit for from the Electric Light Men.

Electric Motors.

DISCUSSION IN THE CONVENTION OF ELECTRIC LIGHT MEN AT PITTSBURGH, FEBRUARY 22—PRACTICAL REMARKS OF MR. HARDING.

After the reading of Dr. Liebig's paper on "Electric Motors," published in our last issue, discussion occurred as follows, Prof. Reckenzaun being called on first.

PROF. RECKENZAUN: I feel very much interested in Dr. Liebig's paper, but I am afraid that the formulas which he worked out on the blackboard are not sufficiently practical for every day use. In the course of my experience in constructing motors and testing them, I have found that neither Dr. Frölich's, nor Dr. Hopkinson's, nor any of those elaborate theories have satisfied the conditions. Now, if any one attempted to construct a motor on the formulas which Dr. Liebig gave us this afternoon, he would simply get into a fearful maze. He has first of all to ascertain several constants, and where is he going to get these constants from to commence with? He will not find them in any text-book. He will only be able to ascertain those constants by actual experiment; and as soon as a man begins to experiment and spends thousands of dollars, he does not want any more formulas at all, but he can go right away and construct motors according to experience. Now, these things are very pretty and very useful to examine after the motor has been constructed, or after two or three motors have been constructed, to examine the relative value or efficiency of each. But until the motors have been constructed, those formulas are absolutely of no practical value. I thought when I heard that Dr. Liebig was going to read a paper on motors, that we, as practical men here, should get some practical figures. With the exception of the resumé which Dr. Liebig gave with reference to the number of motors in actual use, the rest of the paper, although very interesting, and very cleverly drawn up, is of no practical value. Now, I would like to suggest one or two simple formulas which can be applied to the construction of motors. They are not my own invention, but they have been made by Mr. Kapp, of England, who is probably known to many of you theoretically, as he has written the most interesting and most practical book on the transmission of power. I will put some formulas on the blackboard which will be applicable to both motors and dynamos, and you have only two constants to contend with. Now, as Dr. Liebig told us, the magnetic circuit can be treated in the same manner as the electric circuit. That is to say, the magnetic induction varies with the length of the circuit and the sectional area. Now, if we take the magnetic circuit of a motor, or a dynamo, as the case may be, there we have an armature—an iron ring I am now only considering the iron. Now, we have here a magnetic circuit ranging around the field magnet, across the air space through the armature and back. The longer this magnetic circuit, the greater will be its resistance. But that magnetic circuit must be of a certain length in order that we can get a certain amount of wire upon it. Now, Kapp calls the section of this iron ring a; the length of it b. He calls the magnet core A, and the width of it is B. He calls the length of the magnetic circuit in the field magnet L, and the length of the armature circuit l. Then he goes on and ascertains the total magnetizing power. P is the number of ampere turns for the field magnets. He divides P by constant 1,414, which is the resistance of the air space per inch between the iron of the armature and the iron of the pole-piece. Delta stands for the distance—the air space between. This is divided by beta—that is, the length of the air space from here to there [indicating] multiplied by b, which is the length of the armature core, plus the length of the armature core divided by the sectional area, plus twice the length of the field magnet core divided by the sectional area. This gives us a number which we can utilize afterwards in finding the electromotive force of this machine. Knowing all these figures by actual measurement, we can get the electromotive force which this armature is capable of generating. E A equals Z which we have already ascertained by actual measurement, or by the measurement of our drawing, multiplied by which M T then gives us the number of terms of wire of the armature multiplied by n, which is the number of revolutions we want the machine to run at.

This formula you will find is applicable to almost every case. I merely mention this, thinking it may be of interest to those members of the association who make it a business to construct motors, or use motors, or would like to investigate the subject more deeply.

Of course I have been accustomed to the slow, humdrum way of doing business in England. You have probably twenty times as many motors in this country at work for all sorts of industrial purposes that we have in England, and I feel the time is coming when small steam engines will be entirely supplanted by electric motors. because now, as we can construct motors with an efficiency of 75 to 85 per cent.—commercial efficiency, I mean—it is perfectly natural that there should be great economy in using large steam engines to distribute the power and run machinery by electric motors. Now, for any cases where central stations can be put up, small steam engines will soon find their occupation gone.

MR. BRADLEY: Will Mr. Reckenzaun please give us the place where that is found, if he remembers it? In what publication will that be found?

MR. RECKENZAUN: This will be found in some back number of the *London Electrician*. You can also find it in the transactions of the Society of Civil Engineers of London of about two years ago, and you will find a portion of it in Kapp's book on the Electrical Transmission of Power.

DR. LIEBIG: It seems to me that this formula which Mr. Reckenzaun has given, and which is certainly a very practical one, does not differ to any material extent from the Hopkinson formula.

MR. RECKENZAUN: That is the beauty of it.

DR. LIEBIG: This quantity Z corresponds with the quantity which was estimated by Hopkinson in the equation I wrote down. All we have to do is to refer to Hopkinson's curves or Ewing's curves. L represents the length of the magnetic circuit, just as L represents it here. In the case of the air space in the armature, we rub out this F, which represents the function, and we rub out 1. In that case the magnetic induction and the magnetic force are the same. In that way you can construct a curve which it seems to me is extremely accurate.

MR. HARDING, of New York: In regard to certain practical points, we all want to know how much money we can make by selling electric power. Now, possibly a few figures which are the reports from about 80 stations which are now selling the electric current for power may be of interest. It is impossible to fix the price for any motor of any given size. That is to say, you cannot take a five horse power motor and charge $500 a year. That, you will see a little later, is not possible. All of you, in trying to sell electric power, have met that difficulty. The first thing to do is to divide all the classes of industries you intend to supply, say, into two or three classes: First, constant use. If you are running a ventilating plant and charge about $120 for one horse power, that is constant use. You take next such things as printing offices and machine shops—all work of that kind, which we call partially intermittent. In that case the price has been established—and it would be well, I think, to have a price throughout the country, in order to settle difficulties as to what the price of power should be, because the company seems to think that the one who is using the motor wishes to have a very low price, and the one who is using the motor thinks the company wants more than it is worth. First, be sure to sell the machine to the customer. Where motors have been rented, the result has not been satisfactory. It has been tried by gas companies. Steam companies have tried renting steam engines, but the engines are never cared for, and are in wretched condition, and the same will be true of electric motors, and the repairs of the machines, after they have been run for a long time—not oiled and neglected, will more than eat up the profits. Take a half horse power motor: the average price seems to be $75 a year. Of course that is ten hours' service. That would be equivalent to about two cents an hour which for sewing machines is not high. One horse, $120, two horse $200, three horse $270, five horse $425, seven and a half horse power $600, ten horse power $750, and fifteen horse power, and up about $70 per horse power per year. If you sell 15 horse power at $70 a year, the intermittent use will show a large profit. These data we have obtained in this way. On every machine running on the constant potential circuit of the Edison Company in New York—also in other places—they put a meter and they examine the meter at the end of each month, and that data has been of great value, because we know exactly how much the customer is using. Take the third class, which is the elevator work, you will find that to be a very profitable source of income. In elevator work for a five horse power motor, you charge $300 a year for a seven and a half horse power motor $360. You can charge say about $400 for a ten horse power. Suppose a man puts in a motor of five horse power for a small freight elevator—if, however, he has a very large platform he can use ten horse power once to take up a load—you will find he is not using so much current. Now from actual tests, they have found in New York, that on a freight elevator charging at lamp rates, which is 1½ cents for six candle power per hour—that is equivalent to $312 per horse power per year—the actual amount used very seldom exceeds $150 a year, which shows a very handsome profit indeed. If you calculate that you are selling your power at the same rates as you are selling the lights, then if you can make ten per cent. by selling your current for four hours per day, if you can sell current for ten hours a day you are making two and a half times as much, or 25 per cent. possibly. These figures may help some of you in establishing the rates which you shall charge for power. [Applause.]

MR. FOOTE: I want to thank the last speaker for his remarks. He has told me exactly what I came here to find out.

Curative Electricity.

A letter in the *Review* of last week, followed by another in to-day's issue from the pen of Mr. Lynd, brings us to the conclusion that it is high time the public should be made aware of the fact that all things are not what they seem. For many years past the mysterious nature of electricity has been made the means of perpetrating a series of frauds upon the unsuspecting populace, and electricity as applied to curative purposes has, perhaps, been the greatest fraud of all. The number of persons trading upon the credulity of the people in this one branch alone is considerable; but how are they to be suppressed? All we can say, and all we can do, will not avail one jot. Technical journals do not, as a rule, circulate amongst those who are most easily gulled, but, inasmuch as our remarks may be reproduced here and there, we will briefly relate one or two circumstances in connection with the medical electrician's calling which have just come under our notice.

First we have a specimen of a galvano-generator, which is made thus: A small oval frame of a bituminous nature contains a similarly shaped but smaller zinc plate ornamented in relief with "lightning flashes." Placed on this is a copper disk of similar shape, without any separating medium whatever between them. The combination is perfectly dry, and we need scarcely say that the apparatus sent to us is absolutely useless. The second is a magnetic appliance which may be a so-called chest protector, or anything else. Sewn up in a semi-circular piece of silk, we find twelve feebly magnetized pieces of crinoline steel, and this is all; yet the price of the article is said to be thirty-five shillings.

No man of ordinary education could believe that such devices as these can possibly effect any good in the human system; yet, if we may judge from the advertisements of such goods, the sales must be enormous, and the vendors of these articles grow rich at the expense of weak-minded and highly imaginative individuals. We know that electricity, properly applied by a qualified practitioner is efficacious in many ailments, and numerous genuine cures are on record which have been entirely due to the galvanic current; but it must be remembered that electrical treatment may in some cases produce harmful results. We are also aware that a French physician is said to have effected marvelous cures by working upon the imaginations of many of his patients who were inclined to place implicit faith in the virtues of magnetism. The Frenchman simply employed pieces of wood shaped like and made to represent magnets, and with these simple and absolutely harmless objects he effected his purpose.

Knowing this, what good cause could we serve by naming any of the gentry who so successfully trade upon the credulity of the public? We have no doubt about the worthlessness of the apparatus palmed off in the majority of cases, neither have our readers; but if it ever became necessary to bring this matter into a court of law there is every reason to believe that many persons would be found willing to come forward and swear that they had derived incalculable benefit from the use of these so-called curative electrical appliances. This being the case, we do not see how the trade can be rooted out, or even diminished.—*London Electrical Review.*

——Mr. James D. Randall, of the Novelty and Electric Company, Memphis, Tenn., reports the electrical business growing rapidly in his city.

ELECTRIC LIGHT NEWS

—— Mr. C K. Giles, of Chicago, the inventor of the Giles anti-magnetic shield for watches, was a New York visitor last week.

—— The new central station of the Allegheny County Electric Light Company is a splendid instance of solid progress and provision against future demands. It is one of the most substantial of the substantial structures which characterize the city of iron and steel.

—— Among sights viewed by Pittsburgh visitors was the Observatory Hill Electric Railway, just started under the Bentley-Knight system. The difficulties of grades and curves are very severe, and call for quite a heavy duty. A great number of delegates visited the installation and took a ride on the cars.

—— The Westinghouse Electric Company are preparing to bring out a 50-volt 10-ampere arc lamp, adapted to be placed indiscriminately in their standard secondary or converter circuit in multiple arc along with incandescent lamps. There should be a good field for such lamps, and it seems like a move in the right direction.

——Mr. D.H. Louderback has accepted the position of general manager of the Chicago Edison Company. Messrs. Louderback, Fay and Sunny, all former telephone men, now control the lighting of the city of Chicago. The Edison company, with which Mr. Louderback will hereafter be identified, is said to have among its stockholders the largest number of heaviest capitalists of any company ever formed in Chicago.

—— The 4 H. P. Eddy motor exhibited by Mr. Newton, of the Eddy Electric Mfg. Company, took the eye of Best & Co., printers, of Pittsburgh, and they bought it, and are now using it regularly in their establishment. Mr. Eugene Ingold, of Pittsburgh, has been appointed agent for this territory by the Eddy Co.

The same gentleman is reported to have arranged for the introduction of the Slattery Induction System of the Fort Wayne Jenney Electric Light Company in and around Pittsburgh. A central station is to be established, and it looks like hot water ahead, and possibly a cyclone of flying fur.

—— There is a movement on foot among Eastern capitalists to re-open the Chengwatona copper mines. These mines were opened several years ago by J. Bennet Smith, of Wilkesbarre, Penn., and vigorously pushed for two years. The company acquired a large tract of copper lands, extending from Snake to Kettle Rivers, and the outlook was favorable for a rich yield of metal. The recent advance in copper has turned the attention of several capitalists to this point as being a very desirable locality from its geographical situation for mining on an extensive scale. There is no doubt of the richness of the mines.

—— Another death, chargeable, it is said, this time, to an alternate current, occurred in Buffalo on the 5th instant. The cast of characters and properties in the tragedy are: One horse, with wagon; a colored man; a telephone line, and somewhere else an electric light wire with a ground contact somewhere at the back of the scene. The play, as they say in the manual of arms, is executed in one time and two motions. In the first act the horse dies, and in the second the man. Time of representation, a few minutes. A stock company of boys played a one-night stand at Memphis on the evening of the same day. A loose wire twisted around a pole attracted their attention, and they found they could have lots of fun by taking shocks—and they did. The play reaches a climax at the end of the second act, in a funeral cortege from the late residence of one of the lads. A couple of days are supposed to elapse between acts.

Underground Conductors for Electric Currents.

By Jesse M. Smith, of Detroit, before the National Electric Light Association, Pittsburgh.

The question of underground conductors of electric current is one which every person interested in electricity should study fairly and with a predetermination of solving.

It is not purely an electrical question; in fact, the electrical part of it is far overbalanced by the mechanical.

There is no difficulty in finding an excellent insulating material, but the difficulty lies in the holding of this insulator on the conductor.

Many substances are good insulators in dry places; some are good under water; some in damp places; and a few will stand acid and alkaline fumes and the ravages of sewer and illuminating gas; but how many will insulate under all these conditions combined, and, in addition, be substantial enough to withstand the mechanical injuries to which they are exposed when buried under the streets of our large cities?

A few years ago wire wound around with a little cotton soaked in paraffine was thought sufficiently insulated until the insurance companies had a few losses, due of course to electricity, and then we had underwriter's wire.

The name of this wire has sold hundreds of tons of it, but that does not prevent its grounding a whole system when it comes in contact with the least moisture.

It, however, marks one state in the evolution of the perfect insulation.

There seems to be comparatively little difficulty in making a cable that will carry high potential currents when constantly submerged.

The conditions are substantially the same at all times. There are no alternate changes of moisture and dryness; no great changes of temperature; and very little of the destructive action of gases.

The conditions of the underground conductor are very different.

Here the conductor is dry, then wet; it is frozen, and again thawed; it is attacked by sewer gas, and the corroding action of water leaching through the accumulated filth of the street; it is subject to the destructive action of the leaking gas and steam pipes, and finally, but not the less surely, to the ruthless "ditch digger."

These are certainly formidable obstacles, but a number of them have already been overcome, and the others must be.

Public opinion says the wires of all kinds must go underground, and electricians, engineers, and capitalists must find the means of doing it.

The question resolves itself into three parts.

1st. The electrical insulation of the conductor.

2d. The protection of the insulation from the effects of moisture and corrosion.

3d. The protection of both from mechanical injury.

The question of electrical insulation seems to me to be solved by at least six of the standard compounds now in daily use.

The second part of the question is the most serious.

If any of the standard insulations can be enclosed so as to be protected from direct contact with moisture, their chances of life are certainly improved, but if they can be hermetically sealed, they should be practically indestructible, provided the casing is indestructible.

We single out as among the best materials from which to form such a casing—iron and lead.

Cast iron, underground, will last a great number of years, as shown by gas and water pipes, but it cannot be obtained in lengths much over 12 feet, and the numerous joints multiply the chances of leakage. The conductors must of necessity be drawn into the pipe after it is in place.

The conductor must be considerably smaller than the pipe, and therefore moisture will creep in between the two.

Wrought iron pipe, if well coated with asphalt or some similar substance, will last a long time.

It may be had in longer lengths than cast pipe, and the joints are more easily and surely made.

If screw-threaded joints are used the conductors must be drawn in, with the same objections as with cast pipe. If the lengths of pipe are prepared with the conductors in them before laying, joints must be made in the conductor as well as in the casing, at short intervals.

Joints are the bane of electrical construction.

From the dynamo to the lamp and return the current is forced to pass joints which frequently offer more resistance than 1,000 feet of wire.

At these joints the insulation, instead of being better than at other points of the conductor, is generally worse, and oftentimes none at all is found.

It is not strange that the current should seek an easier path home, and take to ground, rather than be forced through the accumulated resistance of all these joints.

I will venture to say that, of all the failures of underground conductors, 90 per cent. are directly traceable to the joints, and for that reason it is desirable to have as few as possible.

The conductor may be obtained in practically any length, and the insulation may be put on continuously, but in order to have a continuous casing it must be formed of some soft and ductile metal which can be closed about the insulated conductor in the course of its manufacture.

Lead seems to be the only commercial metal that will fill these conditions, and there are objections even to it.

Lead is soft and easily punctured, and offers little resistance to crushing or bending, and is attacked by rats.

On the other hand, the corrosive action of the earth has little effect upon it; while its pliable nature permits of its use in many places where iron pipe could not be used.

Being soft and ductile, it can be brought into such close contact with the insulation as to prevent or at least retard the creeping of moisture between the insulation and casing.

It seems to me, therefore, that lead casing offers more advantages and less objection than any other form of protection to insulation as yet open to our use.

The third part of the question, viz., the mechanical protection of the casing, and hence the conductor, is not so difficult a matter.

If an iron casing is used, little or no protection is needed.

The pipe is strong enough in itself to withstand any ordinary abuse.

If lead is used, however, it should be kept from contact with sharp stones, bits of glass or metal, and have something about it to warn the ditch-digger before he strikes it with a pick.

An ordinary square wooden box is oftentimes sufficient.

If it does rot away it leaves a bed of soft mould.

The box may be made of white oak well creosoted, in which case it will last until the next generation finds something better.

If the underground conductor is to come into practical every-day use, it must be so constructed that it may be tapped at any point as readily and with as much certainty as a water main is now tapped.

How many miles of lead water pipes are now buried in our streets?

They are not protected by boxes or conduits of any kind, yet it is comparatively rare that we hear of their failure.

If such pipes filled with water can be laid in the earth without protection, why can not a lead pipe filled solid full with copper and insulation be buried with even more success?

Good workmen can certainly be found who can cut a conductor, splice in a branch and solder it, replace the insulation, and finally wipe a joint on the lead casing with as much ease and certainty as a plumber can make a joint in a lead water pipe and have it stand 100 pounds pressure.

In a general system of distribution there are two classes of conductors, one which we may call through mains or feeders and another service mains.

A number of through mains may be bunched together in a cable, under one casing, where they run in the same direction for considerable distances. These may be drawn into conduits, as they are not to be used between the main distributing points.

Service mains must, however, be so constructed that they may be tapped at any point, and that very readily.

Large sums of money have been spent in New York and elsewhere on conduits for electric conductors.

Are conduits necessary or desirable in electric lighting?

Service wires are of no use whatever if placed within them unless manholes are provided at every 100 feet.

Through mains are certainly well protected when drawn into conduits, but at a great expense.

No engineer would, I think, at this day, risk putting a conductor in any conduit which he would not be willing to trust under water or laid directly in the earth.

Why not take one-half of the money which these conduits cost, and use it in buying thicker lead casing, and bury the conductor directly in the ground or in a common wooden box?

The underground conductor of the future, I believe, will be formed with a core of copper cable, thoroughly insulated by any of the standard and well-tried compounds, protected by a close-fitting lead casing, thick enough to resist mechanical injury, and buried in the earth in such a manner that it may be tapped at any point.

But where is the money coming from to pay for these conductors?

Whenever electric light plants are installed in a thoroughly mechanical and substantial manner, with due regard to the most economical production of power, so that the electric light is perfectly reliable and obtains the public confidence, then the money will be forthcoming.

When capital enough is invested in electric lighting to enable it to cope with the vast sums which have been accumulating these many years in the gas industry, then we shall see our dynamos driven by the waste heat and refuse products of the gas works, and our houses will be heated by gas and lighted by electricity.

Government Telegraphy.

At a meeting of the American Newspaper Publishers' Association held in Indianapolis last week, Col. C. H. Jones, of the Jacksonville *Times-Union*, read a paper on "Government Control of the Telegraph." He read statistics to show that Government management of telegraph lines is very costly, and that the deficit in operating the telegraph in Great Britain is made good by taxation. He added:

"In 1887 over 47,000,000 messages were handled by the Western Union Telegraph Company, and these were sent by less than 1,000,000 people. All the telegraphing in the United States is done by less than 2 per cent. of the population. To cheapen telegraphy by reducing the rates below cost and making up the deficit by taxation means to tax 98 per cent. of the people who never use the telegraph, for the benefit of stock brokers, speculators, gamblers, pool men, bucket shop proprietors, and sporting men generally, who sent 87 per cent. of the messages. The only considerable body of men asking for a reduction of telegraph tolls are the Knights of Labor, not one in a hundred of whom ever use the telegraph. These misguided people are simply asking the government to tax them for the benefit of a class of people toward whom they are so irreconcilably hostile that membership in their organization is prohibited them."

The speaker then considered the subject from the point of view of a practical newspaper man. The newspapers of the United States, he said, are now enjoying the cheapest and most efficient telegraph service of any newspapers in the world. The British telegraph press rate is 25 cents for 75 words during the day, and 25 cents for 100 words at night to each place where but one paper is served, and 4 cents for 75 words during the day, and 4 for 100 words at night each additional paper served. Other figures were given, showing that the American press rate is now cheaper than the same service in England by from one-fifth to one-half. These figures apply to the service of the press associations, the cost of special telegraph service in the United States being one-half cent per word, and in Great Britain one-third cent per word; in the United States, however, the distance is an average of four times greater than in England.

The bill introduced by Senator Collum provides that the night rate for newspaper dispatches, when the same dispatch goes to more than one office, shall be 25 cents per 100 words. This is more than twice the rate now charged by the Western Union for transmitting Associated Press reports, and ten times the rates charged by the same company when the reports are delivered by leased wires to four or five papers in the same city. The truth is that the substitution of a government telegraph service for that of the Western Union on the basis of the Collum bill, would speedily result in one of two things—either the bankruptcy of a large proportion of the newspapers away from the great centers, or in depriving the public of a very large proportion of the news of the world.

But even this, the speaker said, is not the most serious objection from a newspaper man's point of view. The mere suspicion that news had been subjected to government inspection or censorship would reduce by at least one-half the value of that news to newspaper publishers and to the general public. In the presidential election of 1884 a belief gained credence that the Associated Press and the Western Union Telegraph Company had doctored the returns from New York State in the interest of Mr. Blaine. The feeling aroused by this was so intense in New York city that it came near leading to the mobbing of Jay Gould, and even in Jacksonville, where the speaker published an Associated Press newspaper, feeling ran so high as for a time to endanger the value of the franchise. What value would the public attach to news in emergencies of this kind, if they knew that its transmission was through the medium of government employes, which, under existing political methods, means the employes of the party in power?

Electrical Street Railways.

To the Editor of Electrical Review:

In considering the application of electricity to the purposes of locomotion, it should be viewed as a means of transferring energy from one point to another; the problem being to divide up the energy of the steam engine at the station among the cars on the line, and to enable each car to receive and utilize, as it progresses along the line, the proper amount of current for its needs at any given point.

In a cable railway, this is accomplished by having a rope constantly dragged by the power of the engine over the whole length of the line, the cars gripping it at will. In an electric railway, the energy of the engine is converted into electricity and carried by stationary metallic conductors along the whole length of the line, and the cars, as they advance, draw off the electricity by means of a constant sliding connection between each car and the conductors. In general the transfer of energy by electricity is by far the simplest and most efficient method known, and it is so none the less for railway purposes than for any other.

The electric current passes along its conductor without outward manifestation; there is no friction, no inertia, no appreciable heat; it can be taken off at any point and converted into light. An idea of electricity, as a medium for transferring energy, may be had by remembering that each electric arc lamp represents about ¾ horse power of energy. If a lamp is removed from the circuit and replaced by a motor, we have the same energy in the form of motive, or mechanical power. At Rochester, smelting furnaces for bronze employ electric heat, and four machines driven by water power are used, each consuming 500 horse power, and turning it into electricity, which is again changed into heat. A certain amount of energy is consumed by the conductor through which the electric current passes, but by increasing the amount of copper in the conductor, this loss decreases until a point is reached where the interest on the cost of the copper equals the cost of the energy lost in transmission. This is always the point of greatest economy.

While the conveying of electric power by means of a rod or wire of copper is very simple and efficient, it is a very difficult mechanical problem to convey the same amount of energy by a wire rope, as in the cable system. The weight of the cable has to be moved, and it must be supported by sheaves placed along the line at short intervals, while a large tunnel must be built to contain it. The sheaves all consume power and have to be constantly oiled and watched, and by their constant recurrence prevent any thorough cleansing of the conduit. Elaborate and complicated construction is necessary for curves and switches, while the connecting and disconnecting of a heavily loaded car to a swiftly moving cable is a difficult and wearing process. The best cable engineers estimate that more than 75 per cent. of the engine power is consumed in moving the dead weight of the cable, and it rarely lasts over a year, or a year and a half. When electricity is used, on the other hand, the conduit contains only the stationary and permanent copper rods, and no mechanism is employed to wear and give trouble. Connection with the car is maintained by a light sliding contact bearing gently against the conductors. So far, then, as the transmission of power is concerned, the simplicity and convenience of the electrical method is unequaled. Its efficiency is equally satisfactory. The dynamo electric machine by which the power of the steam engine is converted into electricity, has reached a degree of perfection unappreciated by those not engaged in the business. Less than five years ago the best dynamos gave an efficiency of 75 per cent.; there was excessive heating of the wire coils and of the journals, so that a machine could rarely be depended upon for a run of twelve to eighteen hours at a stretch. There were frequent burnings out of the armature and of the commutator, and other recurring faults which caused uncertainty and expense. At present the best manufac-

turers sell their machines, both dynamos and motors, with a guaranteed efficiency of 90 per cent., so that for every 100 horse power of the steam engine, 90 will appear on the line in electricity, and 81 will appear in the motor in the form of mechanical energy. A series of tests made with a railway motor at the Thomson-Houston works demonstrated an efficiency of 80 per cent. from the steam engine to the car axle. From this must be deducted in actual practice, 5 per cent. for the line wire and 10 per cent for contingencies of all kinds, leaving 65 per cent. actually to be relied on. Therefore, from 100 horse power at the engine, 65 will be delivered on the car axle.

The capacity of machines has increased in like ratio. A machine that would formerly operate 35 or 40 arc lamps has been worked up to operate 65. At the same time the reliability of machines has been improved. Their electrical and mechanical construction has been brought to such a degree of perfection that little more can be desired. And while the electrical machines have been worked up to this point, special engines for driving them have been developed, and special appliances devised for protecting both dynamos and engines from all possible accidents and interruptions. This growth has been unostentatious but rapid and sure, and at present the transmission of energy by electricity is thoroughly and completely practicable, thousands of horse power being every day obtained from electric motors. The application of the motor to railway use has been steadily developed during the last four years. Various difficulties have been met and overcome. The conduit system, involving greater difficulties and expense than the overhead system, has gone somewhat slower, but both are now in shape for practical everyday use.

The peculiar adaptability of the electric motor to railway use is not fully appreciated, outside of those intimately acquainted with it. It will be described as plainly as possible. The work of propelling a tramcar is characterized, not only by wide variations in amount, but by wide variations in character. It is measured, in horse power, by the product of the tractive pull into the velocity, and there is found both a variation in the total product and a variation in both of the factors entering into it. For example: Given a loaded car weighing 10 tons, with a traction of 15 lbs. per ton, and a speed of 6 miles per hour, or 528 feet per minute, and the horse power on a level will be:

$$H.P. \quad \frac{10 \times 15 \times 528}{33{,}000} \qquad -3.4$$

If we now reach a grade of 5 per cent., or one foot in 20, we must add to the traction 1-20 of the total weight of the car, or 1,000 lbs., since the car is raised vertically 1 foot for every 20 feet it proceeds. The traction is then $10 \times 15 \times 1{,}000$, and we have, supposing the car to go at half speed

$$H.P. \quad \frac{(10 \times 15 \times 1{,}000) \times 264}{33{,}000} \qquad -9.2$$

That is, the horse power has gone up from 2.4 to 9.2, the traction has gone up from 150 to 1,150, and the velocity has decreased from 528 to 264.

It is evident, therefore, that a motor for street car work must be capable of wide variation in tractive force. In the problem given, the quite ordinary grade of 5 per cent. was shown to require about eight times the traction that was necessary on a level. For this reason the gas engine and various other motors fail. They have little range of pressure, and, while on a level the pressure will be ample for the load, and accelerate the speed so as to do a large amount of work, it will not have sufficient traction for a grade or curve.

In an electric motor, on the other hand, the torque* increases as the square of the current, and is limited only by the magnetic saturation of the iron cores. This limit is so remote that it is best appreciated by the fact that in practice a motor capable of moving 15 tons up a grade of 8 per cent., weighs, with gearing, but 1,600 pounds. In the example given, the increase of traction on the grade could be obtained by admitting to the motor less than three times the amount of current necessary on the level.

It is another peculiar feature that the necessary increase of current automatically takes place by reason of the tendency of the electric motor to slow up under an increased load. This slowing tendency, and the acceleration due to the resulting increase of current, meet each other at a point always dependent on the load at any given time. This follows from the following considerations:

A dynamo and motor are the same machine working in converse ways, the dynamo converting mechanical into electrical energy, and the motor converting back electrical into mechanical energy. When acting as a dynamo the machine has also a motor action, due to its own current, which opposes the driving engine, and in overcoming which the power of the engine is consumed. When acting as a motor, on the other hand, it has also a dynamo action, tending to set up an electromotive force against the direct or actuating electromotive force.

The efficiency of the transmission depends on the ratio between the direct and counter electromotive forces, and, as the resistance of the motor is constant, the current through it will depend on the excess of the former over the latter. To put this into a formula: Let E be the direct and E' the counter electromotive force, R the resistance of the motor, and C the current. Then by Ohm's law that the current equals the electromotive force divided by the resistance, we have:

$$\frac{E - E'}{C - R}.$$

Now, E is always constant, while E' varies with the speed of the motor, so that as the speed, and consequently E', tend to diminish, C increases in the same ratio, and the torque of the motor, increasing as the square of C, tends to restore the speed. There are other elements which come in to modify this result somewhat. In a series wound motor E' is increased not only by the speed, but by the increased current acting on the field magnet of the motor, so that E' is a function both of the speed and strength of field magnet. But as a fact in practice, the torque automatically increases in a much greater ratio than the speed decreases, corresponding very closely with the variations in torque and speed, which the service on most short railways demands.

For the large majority of cases, therefore, the electric motor is nearly self-regulating, an artificial resistance being used for stopping and occasionally for going very slow and restraining too high speeds.

The great capacity and compactness of the electric motor are evident qualifications for railway work. ENGINEER.

New York, Feb. 16.

* The torque of a motor is its rotary pull. The torque of a motor in pounds, multiplied by the speed in feet per minute, gives the foot pounds of work the motor is doing. The foot pounds divided by 33,000 gives the horse power. The torque of an electric motor corresponds to the steam pressure of a steam engine.

In a steam engine the force element is the pressure; in a motor it is the torque; while the horse power, or the rate at which a machine can do work, can only be known when the velocity is brought into account.

*** What a climate this Nor'western is, to be sure, to grow telegraph plants! A Detroit interviewer published this the other day—which shows how like Banquo's ghost the opposition telegraph business is:

Marcus Pollaski, of Chicago, was at the Russell House to-day, in consultation with prominent capitalists who are interested in the Chicago Postal Telegraph Company. Mr. Pollaski is *en route* to the Upper Peninsula, where a number of wealthy men are backing his efforts to give them additional telegraph facilities. The Baltimore and Ohio only a short time ago, froze out the Inter-State Telegraph Company, which was running lines from Detroit to Kalamazoo and from Detroit to Fostoria, O. The Chicago company has negotiated a purchase of these lines and also the Toledo and Ann Arbor lines from Toledo to Cadillac. The company expects to run lines in Michigan, Ohio, Indiana, Illinois, Wisconsin and Minnesota, purchasing short lines and building connections. It is expected that the company will be able to begin active telegraph business by May.

New Telephone Work in Chicago.

Chicago has a prospect in the near future of trying what a new system of telephone switchboards, together with other improved methods of handling the business, will do. There has been in the past an immense quantity of scolding, occasionally a swear word, often a large amount of ill-feeling, a letter of complaint now and then, and the telephone girl has led a life of alternate sunshine and April showers, all on account of the switchboard or the something in the service which bred these disturbances in ordinarily quiet bosoms.

Several systems of board have been essayed, and a snug little amount has been expended in trying to substitute something different from what is to-day acknowledged by all to be the only and perfect method of handling the telephone business—the multiple switchboard.

The Chicago company is now building an edifice on the corner of Washington and Franklin streets, which will be a permanent ornament to that portion of the city. The lot upon which the building stands is 40 x 90 feet, and is covered by the structure. The first story of the building is of rough Waupaca granite, while the remaining six stories are of pressed and moulded brick with terra cotta trimmings. The building is as thoroughly fireproof as possible, fitted with freight and passenger elevators, and every modern appliance for convenience and comfort.

The basement will contain the steam and elevator apparatus and storage room for the coarser materials and appliances of the construction department. The first floor will be occupied by the supply department, and will also contain warehouse room for instruments, etc. On the second floor the offices of superintendent, assistant superintendent, and repair department are to be located, while the third will be occupied by the president, secretary, and other general officers of the company. Immediately above these last the entire suite of rooms will be occupied by the general officers of the Central Union Company, which has its exchanges scattered through Ohio, Indiana, Iowa, and Illinois, and over which President Phillips, also of the Chicago Company, presides.

The offices on the fifth and part of the sixth floor will be for rent. The rear rooms of the sixth floor will be used by the toll line department, cloak and lunch rooms, and the upper floor will be occupied by the City Exchange proper.

Two of the present south side exchanges, and part of the north and west sides, will be thrown together in this room, and by thus putting several in one, the delay in making connections will be much shortened up, as the greater portion of the business district of the city will thus be all on one set of boards, while at present four offices have to make connections for a large proportion of all the local south side and many of the north and west side calls.

Some idea of the substantial elegance of the building, which has been carefully planned, may be gleaned from the fact that the cost of the edifice alone will be something between $75,000 and $100,000 before it is completed for occupation, May 1 next.

The arrangement of wires will be such that the chronic eavesdropper who endeavors to listen to conversations over other people's wires—he never knows whose, and is never quite sure what the speaker is talking about—will be deprived of his opportunity of saying smart things, and having the fun such wisdom has heretofore enabled him to thus enjoy; for eventually metallic circuits will prevent all induction and "cross talk" from one wire to another, and this in turn will prevent cross talk to the lady operators.

Seventeen cables, of 200 wires each, will enter the basement from the underground conduit, at the corner of the building, pass through to the rear in an iron case, and thence to the second floor, where the cable terminals will be placed. The heavy cables cease as such at this point, and the wires, in pairs, are gathered into bunches of one hundred. These are made into office cables, and are then carried to the distribution boards on the upper two floors.

Telephonic News

*** The new Chicago board is a combination of sections of 200 terminals, and the total immediate capacity will be 3,000 lines, with an ultimate capacity only limited by the convenient reach of the operator's arms. Each new section added comes into the ranks full fledged, and as capable of doing its work as any of its predecessors.

*** The young man had been trying to tell her how madly he loved her for over an hour but couldn't pluck up the courage.

"Excuse me a moment, Mr. Featherly," she said, "I think I hear a ring at the telephone." And, in her queenly way, she swept into an adjoining room

Presently she returned and then his mad passion found a voice.

"I am sorry Mr. Featherly," she said, "to cause you pain, but I am already engaged. Mr Sampson, learning that you were here, has urged his suit through the telephone."—*N. Y. Sun.*

*** A peculiarity of the Chicago telephone board is a novel method of distribution, by which the amount of work done by the operators can be more thoroughly equalized without in any way disturbing the individuality of the lines. Methods will also be provided by which the disconnection of the trunk lines—lines leading from one district to another—will be more promptly accomplished, when these have performed their duty in a connection. The repetition of the number wanted, which is a source of constant annoyance, will not be necessary under the new arrangement—the operator who answers the ring being charged with finishing the work of getting the two parties together. Another advantage will be the rapidity with which the connections are made will enable the operators to clear up the boards more frequently, because the time now expended in waiting will generally be sufficient for the entire transaction. If the theory is correct, there will be a large percentage of time saved to the subscriber and to the employe as well. It is safe to say that the average time required for a busines. day call will be less than thirty seconds. Telephone conversation is generally accomplished in less than two minutes. This assumption is based on the actual daily service in several exchanges where the multiple switchboard system has been in use for some years.

*** An incident of the Grand Army Department camp fire in Portland, Friday night illustrates the fondness of the old soldiers for joking, and the equality between members that characterize their annual gatherings.

The venerable ex-Vice-President Hannibal Hamlin, as honored guest and most distinguished person present, was one of the speakers of the evening. His address was an easy, off-hand talk, mainly upon the progress and great developments in science and the arts that characterize the present century. In the course of it, he said, speaking of the telephone:

"And yet, perhaps, more marvelous than all is that little instrument which puts us in communication with those we love a hundred miles away. My wife and your wives have tongues, as it were, a hundred miles long, and if by that little thing of a telephone I were in communication with my good wife at the present moment, I should hear her saying: "Hannibal, be careful and not catch cold."

An hour or so after this, when the memory of Mr. Hamlin's address had been partly obliterated by speakers who had followed him, Past Commander Sawyer rapped to order, and announced a telephone message from Bangor. All eyes turned in the direction of the venerable Bangor statesman, where he sat surrounded by a bevy of young ladies who were importuning him for autographs. Mr. Sawyer, continuing, said: "Ladies and gentlemen, we have received a telephone message from Bangor. It says: 'Hannibal, don't flirt with the girls.'" The applause that followed drowned reply.

The Distribution of Electricity by Alternate Currents.

PAPER BY T. CARPENTER SMITH, BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, FEB. 23.

The distribution of electricity by means of alternating currents, though comparatively new in this country, has already reached such an enormous importance, that it is with great hesitation that I venture to speak upon it, even though limiting myself to the strictly practical side of the work, dealing only with the apparatus as we receive it from the hands of the manufacturer, and leaving out entirely the question of the efficiency of dynamos and converters. It is only the knowledge that the mistakes of those who enter upon any new line of business, are the rounds of the ladder by which we all attain success, that emboldens me to lay before you some of the conclusions at which I have arrived after several years' experience of varied types of electric lighting, both by the arc, by the direct current incandescent, and the alternate current incandescent.

The subject naturally divides itself into several heads, but I would first say that it appears impossible to lay down any general plan of distribution, which shall be practicable in all cases. In almost every town a different plan will be required, and this will depend in most cases purely on local circumstances. Systems and methods that would be admirable for thickly settled and densely populated districts will not be successful in thinly populated and widely scattered ones. I wish it to be understood that, whenever I speak in this paper of success and successful systems, I mean successful entirely in a commercial way, and the conditions of this commercial success will vary in every town and district. I will therefore content myself with describing the method which I have found to be most successful in the various districts with which I have had actual experience, and leave it for those who may be called on to design and lay out the lighting of any particular district to judge for themselves which line of action to pursue.

Naturally, the first part of my subject is the dynamo, and the station detail. I have tried the small and large dynamo, and have concluded that it is a very great point to properly proportion the unit size of dynamo to the probable size of the station; that is, not to have dynamos of different sizes, but to first determine what the unit shall be, making it as large as possible, and then make your whole apparatus additions to that unit size. This simplifies matters very much, enabling machines to be interchangeable, both as regards their parts and their work, and this I am sure will be admitted by all who have ever had the annoyance of a breakdown on engine or machinery, when perhaps they had standing idle plenty of apparatus, which, from various circumstances, could neither be used itself, nor be robbed to repair the breakdown.

I would drive each dynamo by a separate engine, and this for several reasons: By proportioning the engine to the dynamo, it will be possible to have the engine running slightly overloaded, when the dynamo is doing its utmost during the hours of heavy lighting; and as this extreme load falls off to the lighter hours of running, the engine will be working at its point of best economy, instead of running underloaded, and thereby wasting steam. Thus, we use in our station on Virgin Alley, dynamos of 2,500 lights capacity each, driven by 200 horse power engines. During 16 hours of the day these dynamos run, driving 2,000 lights, and the engines are cutting off at quarter stroke, and developing 200 horse power. During the other eight hours, we have driven these dynamos as high as 2,800 lights, during which time the engine was of course overloaded, and not working to so good an economy, but eight hours of overload is not nearly so wasteful as sixteen hours of underload; again, we have had it very forcibly demonstrated more than once, that if the engine be only large enough to drive the dynamo with ease, a heavy short circuit on the mains outside will simply pull the engine up or slow it down, without destroying the dynamo, and only those who have seen a nine foot fly-wheel running at 250 revolutions per minute on a 200 horse power engine, slowed right down in almost an instant of time, can realize the terrific strain to which everything is subjected in such cases, and I would mention right here, that the element of time is a very great factor in such circumstances, as, in an accident of this kind, mischief is often done before the safety catches can melt out. The direct belting of the engine to the dynamo is always to be preferred; shafting is, except under exceptional circumstances, simply a nuisance for incandescent electric light stations, and the economy of one large engine over many small ones has been enormously overrated. For arc light work, where the lights are all lit and extinguished at certain hours, the large engine is good; but for incandescent work, where the load is absolutely out of the control of the station, it is impossible to steadily run a large engine at anything like its most economical load, whereas, with separate engines, the machines can be started and stopped the moment that they are needed or are done with, while the oil from shafting will always cause more or less grease and dirt.

For central station use, except for very small plants, I should certainly use separately excited dynamos, and should do the exciting from two or more dynamos, each capable of exciting the whole system In this way, with the station running at its normal, the only regulation required is that obtained by working the single rheostat in the field of the exciter, and, as we have designed our station at Pittsburgh, this will mean the regulation of 15,000 lights by one six-inch hand wheel. Of course, each dynamo should have its separate field rheostat, to make up for any slight difference in speed of engines. The two exciters should be so arranged that they can be run together or separately, or that either can do the whole work, which of course is easily accomplished by feeding them into a separate pair of exciter bars on the switchboard, and charging the fields of the alternating dynamos from these. The general question as to whether it is better to use separate circuits for separate machines, or to couple them into a general set of 'bus wires and distribute from them, is too large to be lightly decided, as also is the question as to whether it is best to run separate circuits for separate districts or to run into a general system of high pressure mains outside of the station, feeding into these mains at different points, and again distributing from them; and I am not prepared to express any preference, but think that local circumstances will generally decide this question There seems to me little doubt that in underground systems the network of high pressure mains would be the best, but for overhead work we have adopted the system of separate circuits from separate dynamos, using a switchboard which enables us practically to run any circuit or any number of circuits from any dynamo, and running these dynamos separately and not in multiple arc. In spite of the utmost precautions, the unregenerate telephone and telegraph men are always hauling wires across our high pressure mains and feeders, and while their wires, and not ours, generally suffer, after hearing the frightful roar that comes from the dynamo which is running the particular circuit so crossed, we always feel relieved to know that only one dynamo is in danger of being thrown out by the slipping off of the belt—and a twenty-inch belt is not a pleasant thing to have flying around loose. In case of any trouble, such as fire, circuit broken down, or anything of that sort, we can pull the switch of that particular circuit until we can cut out the part affected. The system that I have laid out for use here will of course take a long time to introduce, in view of the fact that we are changing from one system to the other, and have to be governed largely by the location of our lighting, our existing lines, and the possibility of putting up additional pole lines; but it takes, in my vision, the form of a series of heavy mains down the main streets, with cross lines on the cross streets, with switches on the poles, enabling any of the cross streets to be run from the mains on either of the main streets, so that, in case of a fire on one of the main streets, the section represented by the block in which the fire occurs can, by the pulling of two switches, be completely cut off, while the cross streets on either side of the section will enable the lights beyond the fire or broken circuit to be operated, with only the trouble of a slightly larger percentage of loss and the consequent dimming of the lights.

For the main overhead wires, I must harp upon the old string, which cannot be struck too often, namely, high insulation. For 100 volt current work the old stand-by of "undertakers'" wire will pass, but when it comes to 1,000 volts difference of potential, and 130 or 140 amperes to back it up, one realizes very quickly that nothing is too good to curb this fiery steed. We are still paying the penalty of early ignorance in having many circuits of underwriters' wire stretched upon our poles, and I have stood and listened with fear and trembling to the howls of a new dynamo which had only been in operation for a few hours, when we had four short circuits in as many minutes, caused by dead wires falling across these mains on a wet day; while, on the other hand, I have been gratified beyond expression to see our linemen remove ten or twelve old bare iron "district call" wires, which had been hanging all night right across our high pressure, high insulation mains, and this during a soaking rain. Especially should the service wires to the converters be of the best insulation, not only for fire, but for protection to life; for, while the shock does not kill, even a 100 volt shock may make a man start so as to fall off a ladder—and any death or injury will be credited to the electric current. We have adopted a standard of a separation of three feet between the two wires nearest each other on our cross-arms, and do not allow, under any circumstances, the tapping of service lines directly to these wires All services must be attached through the medium of a small spreader on the end of the cross-arm, which I have no doubt all those present have noticed on the streets.

In some districts, where the number of lights in each building is small, we run secondary low pressure mains, and place the converters on the poles, and make our distribution from our secondary mains, but our experience has been that this is not a very satisfactory way of doing. The percentage of loss on these secondary mains, unless the wires are very large or the converters very numerous, either of which is objectionable, causes such a decided variation in the lights as to give grounds for numerous complaints.

The question of the loss on the high pressure feeders and mains is one which I think has not received enough attention. When the alternating system was first introduced, so much was said about the extreme smallness of the wire required that a great many of the arc light fiends throughout the country, who had been accustomed to congratulate themselves on the fact that No. 6 wire was big enough for a 20 mile circuit, immediately jumped to the conclusion that because it was a high tension current, No. 6 wire was big enough for all cases; and consequently more than one case of dreadful grief has arisen. I have laid out our circuits on a certain fixed plan, which is, that each circuit shall be laid out for 1,300 lights (that being the size of unit which we at first adopted), and made of such sizes as to carry these 1,300 lights with a loss of not more than two per cent. with the whole load on. By having feeders large enough for this, we prevent any noticeable difference in candle power from one end of the circuit to the other, and should we be even compelled to run a light circuit and a loaded one on the same machine, the increase in the one or the decrease in the other would not be injurious. Of course we try to so arrange our circuits that the load shall vary about the same on each, but the suddenness with which storms creep up in Pittsburgh makes our load very uncertain and erratic. We have run for three days and nights with only a little more than half of the machinery in operation, and then from Monday night to Friday morning have had to run every incandescent machine in the station under a load that fairly staggered it.

I now come to the question of the placing of the converters, and for this I think you may safely lay down the general rule that wherever you are simply carrying current, do it at high pressure, and keep your low pressure for the purely local distribution. With proper precautions, I do not see that there is any real danger in carrying the high pressure wires into and through the building. If a thousand volt current from a central station is not to be allowed in a building on account of its dangers, then every arc light plant—whether from central station or an isolated plant in the building—must be condemned for the same reason. Of course, the cases where two wires of an arc circuit with a difference of potential of 1,000 volts, are run close together, are not nearly so many as must be the case where there is a constant difference of potential of 1,000 volts in the alternating system; and again, of course, we have the fact that the direct current on arc circuits is generally not more than 20 amperes, while, as I have remarked before, our alternating circuits run as high as 130 amperes; but the fact that one is a direct, and the other an alternating current, largely makes up for this difference. With all due respect for the many gentlemen who have discussed so learnedly on the deadly alternating current, and on the frightful results therefrom, and whose experience with the alternating system is mostly confined to the magneto bell or induction coil, I must maintain that the alternating current, while it is in mild doses of from one hundred to two or three hundred volts intensely more disagreeable than the direct current of the same voltage, when it comes to 1,000 volts, or more, it is very much less dangerous to life. I make this statement with the more confidence that I have tried them both, and we have in our station here not one, but half a dozen cases where our linemen and dynamo men have received the full 1,000 volts, generally being pretty badly burned at the point of contact, but experiencing no ill after effects, while, whenever any of our men receive a shock from one of our arc machines, they are nearly always sick for a day after. This very fact of the alternating current being more disagreeable adds to its safety, as the men are disinclined to work on the wires, even when there is only a slight leak, where with the direct current they will often take much greater risks. In carrying our high pressure wires through the buildings, we have adopted the invariable rule that they must be carried on porcelain insulators, and the wires themselves waterproof, in all cases. We do not allow them to be run in moulding, but where the wires are to be concealed or protected, a casing is run around the wires outside of the porcelain insulators, giving them a perfect air insulation, and hard rubber must always be used for floors and walls. The converters are all placed with porcelain knobs behind them, giving an air space of two inches between them and the wall, and we prefer in all cases to put them against brick, rather than against wood or plaster. I understand that in some districts the use of converters inside buildings has been forbidden, but I think that this position is a most unjust and untenable one. The only argument that can be brought against their being placed inside is the danger to life or of fire. For the first, the converter is well insulated, and is placed high up out of reach, and most potent argument—though one I am sorry to say often refused recognition—it is not placed there to be handled. As regards the danger from fire, all the converters with which I have had any experience are boxed up completely in iron cases, the only opening in which is a small one at the bottom, for ventilation. They cannot possibly get hotter than the melting point of lead, for the simple reason that if they should the fuses would blow out and cut them out of the circuit, and any one who has performed the old experiment of melting lead in a piece of paper, can easily see that this heat is not liable to set anything on fire, and even should the converter burn out, no flame can escape from it to set fire to anything, however inflammable. If the converter is to be banished from buildings on account of danger from fire, then every stove, high pressure steam-pipe, and for that matter every gas jet, must also be banished.

In a Chinese firecracker lately published, I find the statement that Inspector McDevitt has relegated to the cellar all converters, and that he says that in the first case of explosion or fire from them, they will have to go to the street. Now, as vice-president of the company owning these converters, I have simply to say that this is not so, and that the converters are placed all through the buildings, wherever we may desire to have them, and only three or four are in cellars. Moreover, so far from Mr. McDevitt making any such statement, he has steadily refused, even under the most urgent solicitation of the Chinese gentlemen, to make any such restriction, but has very properly stated that until an explosion or fire occurred, he can take no such action. I speak of the publication as a "firecracker" for three reasons: first, because it is red; second, it is chiefly noise; third, a good many crackers are only fizzles

As regards the liability to burn out, and the danger therefrom, I can only say that from over 600 converters of all sizes, from 5 to 50 lights each, in an experience extending over twelve months of constant service night and day without any stop, we have had but three actual cases of burning out, two of these being 5 light converters, and one being a 50 light converter. The two 5 light converters were simply slowly roasted out from overloading, until finally the insulation on the primaries was charred through, when the fuses blew out instantly, and all was over. In one case the customer had been attracted by the converter singing, and was standing looking at it, when his lights suddenly went out, and he had to go into a neighbor's store to know whether the trouble was in his lights only or with the main circuit. The 50 light converter suffered in the same way, having nobly endeavored for some two days to run 120 lights. It was one of three on a section of secondary mains, and the lineman who had been sent out to examine them, owing to complaint to us of poor light, reported that two of them were all right, as they were cold, but that one of them was bad, as it was very hot, and preparations were being made to change this converter, when a message was received from one of our customers that the "stove on the pole" in front of his place was smoking.

Investigation showed that both plugs in the other two converters were blown, and the only reason that this one had not followed suit was the fact that some ingenious gentleman had made them of copper. We have had three cases of defective converters; that is, converters with a wire broken inside, or short circuited, so that the moment that the current was put into them they would blow out all the fuses, and if new fuses were put in they would again blow; but the men in these cases, of course, immediately returned them to the shop for examination. That is to say, out of the 600 converters, we have actually had to remove or repair one per cent. in actual service; and I submit that, on a total converter capacity of 17,000 lights, this is a very good proof that these converters are well made and not dangerous.

In all of our experience we have not had one single case of connection between the primary and secondary, or the primary and the shell of the converter, even in the case of the burned-out converters, and we had, just a few days ago, the first case of a connection between the secondary and the shell of the converter.

We started in with the idea that it was better in cases where we had, from the number of the lights in a building, to use more than one converter, to bank them; that is to say, connect all the primaries and all the secondaries in multiple, and distribute from this 'bus wire; but two or three peculiar experiences have led us to change our plans, and never to do so if it can be easily avoided. We had two or three unfortunate cases where one converter of a bank, for some unknown reason, would blow its plugs, thus overloading the others; then perhaps another would

give way, and thereafter it was a race as to which would blow its plugs the quickest. It is not calculated to make one feel comfortable to have 400 lights in a theater go out at once, just as the curtain was about four feet from the stage, in the beginning of the third act; yet this was our experience last Christmas day. We had the converters fused up and running in half an hour, but next day the same thing occurred, though the gas-man, seeing the lights dim down, was quick enough in shutting off his different circuits to stop three or four converters, which gave him lights enough to pull through. We have cut this building up, and each converter now carries its own load, with the result of our detecting one of them, which, for some reason unknown, always tried to do more than its share of the work; but while we have marked it, we have not troubled to change it, as, working singly, it does its work well. We have had another case of the same kind in another bank of converters, which have also since been cut apart, when we found the trouble arose from a poor connection which heated up the fuse to melting point; yet, as we have in the City Hall two banks of 12 40 light converters each, and in the Union station a bank of 23 40 light converters and 3 20 light converters, which have never had the current off them for nearly three months, and have never had a single converter of all these blow its fuses, we cannot say that this result would always or even generally obtain; but as the object of banking is primarily to prevent the total extinction in case of one converter going out, and this is better attained by the judicious running of the secondary circuits, we prefer keeping the converters separated.

For the secondary wiring in the buildings, we need lay down no laws. The rules governing this are too well known to need any repetition. One advantage of the alternating system, which was first brought to my attention by one of our wiremen, is the fact that wires carrying the alternating system do not blacken the surface on which they run. We have in our station circuits of direct and alternating currents side by side, put up at the same time, on a ceiling painted in very light colors, and which have been burning the same number of hours. The paint under the direct current wires is very dirty, in the usual style, and the wires themselves are covered with a black deposit, while the alternating current wires, and the ceiling on which they lie, are as clean as the day when they were put up.

There yet remains one point on which I wish to say a few words, and it is a subject of the greatest importance. Now that the alternating current distribution is a pronounced success, there is no reason why the places of all others where incandescent light is most desirable, namely, in residences, should not enjoy the advantages and improvements from which they have hitherto been debarred by their distance from the usual center of distribution, and it is when we bring electricity into the dwelling-house, where it will be daily and hourly needed and handled by women and children, that we realize how absolutely necessary it is that we use anything and everything which can tend to make safe its introduction and manipulation. Of course the first, second, and third of these are, good insulation, better insulation, and best insulation; but besides this, there are other points to be considered, and one that seems to be worthy of very careful consideration, and the fullest discussion, is that which has been more than once suggested, namely, the making of a permanent ground connection with the secondary wires. The object of this, of course, is, that should a leak occur at any point between the primary and the secondary, the current, being already grounded, will render it impossible for any one to receive a shock by touching the secondary, and at the same time making an earth connection. When I first considered this question, I said in my haste that this was not a proper course of action, as one is simply provoking a ground at some other point, and seeing the careful insulation of the converters we use, I could not see any danger of a leak across; but I have since made up my mind not to come to any conclusion at all until I have considered and heard some discussion both pro and con, and for this purpose I should like to hear the most bitter partisans on either side, that we may get from them every little weakness on either side of the question brought out.

In a paper like this, it is impossible to do more than to give the mere sketch of the subject, but I trust that what I have said may be the means of inviting discussion and inquiry, for it is only by this means that we can arrive at the true facts of any case, and, as we all know, the electric light industry has suffered more than tongue can tell from the general ignorance of its dangers and requirements, which hindered and injured its early introduction into this country, and which led to the spending of so much good money on plants and wires which were not merely insufficient, but absolutely dangerous.

Now that we have taken, as it were, a new departure, and entered upon a new era of progress, let us not fall into the same errors which marred the early history of our business, but strive with might and main, by discussion and interchange of experience, to make each new installation another stride toward perfection in what I think is undoubtedly the greatest achievement of the age—the distribution of electricity by alternate currents.

The Discussion.

Prof. Forbes: I cannot speak upon the subject of Mr. Carpenter Smith's paper on the alternating system here. It is a most valuable paper, and one from which I myself have learned a great deal, and have taken numerous notes for our benefit on the other side of the water. With regard to Mr. Shallenberger's very interesting paper, I may say that I think those experiments which he has described are very beautiful indeed. I have been lately much occupied with the theory of alternating currents. The point which he has chiefly brought before us is this—that you must not try to get out of an alternating current circuit the work which is being done in that circuit simply by multiplying the volts by the current, because there is a difference between the current and the expressed electromotive forces. As matter of fact, the formula comes out very simply indeed—that the true work is really the produce of the electromotive force multiplied by the line current. It will be easy to get at the figures which give you the value of the cosine of that angle pretty easily, but it involves a little mathematical work, and this is hardly the place for that. I have communicated this formula to the Society of Telegraph Engineers in London since my departure from London, and it will probably come to those who are interested in applying the formula to practical work.

I do not think that there is any point on which I can give information here, but I shall listen with great interest to the discussion. Since the subject of alternating currents has been brought up, I wish that somebody had given us a little information about a question which has been occupying my attention so much during the last year in connection with alternating current—the question of meters. I would like to hear what has been done in the matter of meters for alternating currents, because it strikes me there lies one of the chief difficulties in the practical working of central station lighting. Having my own idea of the solution of the difficulty, I would like to have heard from other people what the complete solutions are, or else what are wanting. I think that would have added to the interest of the discussions on the alternating currents. I am sorry that I really have nothing to give you that would be of value to the association.

Dr. Moses: I am delighted that the article which Prof. Forbes has elaborated will appear very soon. I had occasion to try one of his formulæ, and it was practical and useful. With regard to the question which he asks about the measurement of alternating currents by means of a meter, it is, of course, a most important question, and one lying at the very root of all electrical distribution. In fact, it was one of the first ideas evolved as to the distribution of electric currents over large areas for ordinary use as a substitute for gas for illuminating purposes—(the question of motors was not then considered particularly)—and it was resolved to adopt a continuous current, not because a continuous current machine, as then known, was better than an alternating machine, but simply because continuous currents permitted of the registration of the amount of electricity consumed in any work by the various methods known at that time. When that was finally adopted by Mr. Edison, who first worked in that direction, he took the electrolytic method. That had already been discovered and elaborated in a most magnificent manner by Faraday, who had, theretofore, discovered so many very important facts, and among them I might name the sublime law of chemical equivalents. That had been completed before, but he adopted it in his system for the measurement of continuous currents. It was simply a question of deciding on which side of the mountain range the water was going to flow. I speak of him as typical of those who have adopted continuous currents for distribution. Before this, of course, the alternating current had been used for lighting purposes; and, in fact, the first dynamo machine that was made was an alternating current one, but there were some practical difficulties in the way. And here, parenthetically, I would wish to say that so great an authority as Bacon has before said, that one should be aware of things—meaning by that, popular reports flying about. He cited one case which will illustrate by anecdote what I mean by things, when he said that Cæsar managed to come into Italy by spreading the report abroad that his soldiers were afraid of Pompey's; the actual fact being the reverse; and Pompey's men then became over-confident, and we know the result. The fame was spread abroad among the people at one time to the effect that the Pixi machine and other machines which introduced the alternating currents were highly dangerous. They were used for medical purposes; and whoever has had an induction coil put through him does not want it a second time, if he is sensitively strong. For that reason, alternating currents were abandoned, and for no other reason that I know of. Now we come along to another period, when people had become familiarized with the handling of currents, and it has been desired to use the alternating currents for illuminating purposes. It has been successfully introduced, but that link was wanting which the far-seeing mind of Mr. Edison supplied in his particular system of distribution—the meter for the registration of the quantity of current consumed. Every one is familiar with the gas meter; every one knows that while it is altogether unreliable, still it is a kind of fetich that we must worship; it may tell the truth; it generally does not; but still, it is a something. Now, in the alternating current distribution there has heretofore been no such thing. I am glad to say that I have had the privilege—one of the many privileges extended to us all here by the Westinghouse companies — to inspect every part of their vast establishment; they throwing open to us all their secret doors, and, in fact, focusing our attention on the things that we would like to see. And, among other things, I have seen a meter which I would take occasion to particularize here as being one most admirably adapted to the registry of alternating currents; and with this excellent addition, that it will speak the truth; and with this corollary to it, that we can verify it ourselves; and we do not need inspectors to go around; we do not need to use weights and measures made by ourselves. I have to speak guardedly of this, because I was told at the time that the meter was shown to me, that while it was shown, still, for certain reasons connected with the taking of European patents, and such things, it was not desirable that the particulars concerning it should be promulgated; but I vouch for its success and accuracy. That meter is absolutely positive; it is simple, accurate, and cheap. It cannot get out of order. We cannot doctor it. It is there to speak as truthfully as the current itself. I am also very happy to say that a meter—a most ingenious and practical, as well as scientific piece of apparatus—has been invented by Prof. Forbes, which I have not had the pleasure of seeing, but which I have read much about, and which also answers many of the conditions. Now, gentlemen, I think that if you will take the answers of Prof. Forbes in a more earnest way than you took my first proviso about the success of the alternating system, and if you will only accept that statement, you may go home perfectly satisfied that hereafter alternating currents will be sold by the measure, by the quantity of the current absolutely consumed, and that the supervision of the bills charging for that current can be overlooked by the consumers themselves without any difficulty whatever.

Patchogue for Electric Lighting.

The five thousand residents of that prosperous Long Island village are in for electric lighting. They had a foretaste of it one year ago, when the village miller secured a small dynamo, and by the water power which turned his mill, forced a few rays upon the main street. The effect was as striking as it was novel to the native element of "Oysterville." The spread of electricity has been agitated thoroughly, even the village stores during the winter nights being turned into debating rooms at which one or more of the village patriarchs usually presided. The meeting of two weeks ago, held in the Hotel Losee, capped the climax. "Uncle Austin" Roe presided, with Hon. George F. Carman as secretary. There it was voted to form a company, with a capital of $25,000 One week later the desired amount was subscribed, and will be paid in by March 1, when new and powerful Thomson-Houston dynamos are to take the place of the "primitive venture," and the village will reflect her natural beauty beneath the light electric. Concerning the enterprise a village paper says:

"As evidence of the confidence of our business men and capitalists in the enterprise, it need only be stated that all the stock is taken, and there will be no more for sale, only as individual owners may have occasion to part with it. The whole amount of stock is to be paid in by March 1, when the company will come into possession of the plant and the mill property. The company will add new dynamos, and enlarge as fast as the community call for the light."

* * An inventive German has devised a coffin for the convenience of those who have a dread of being buried alive. It is provided with a valve, by means of which fresh air is admitted in quantity sufficient to support life, and there is an arrangement of wires, by means of which the least movement of the body sets an electric bell ringing.

The Thomson-Houston Plant in Lynn, Mass.

The growth of the business and the great popularity of the apparatus manufactured by the Thomson-Houston Electric Co. has astonished even those familiar with the worth of their system.

The Thomson-Houston Electric Co. began business under its present management in 1883. Much money was spent on the perfecting of the apparatus, and the business rapidly increased, until to-day it stands one of the most successful and largest concerns devoted to the manufacture of electric lighting apparatus.

From a factory turning out three machines a week to an immense establishment manufacturing daily more than twice that number seems incredible, yet such has been the change.

Let us enter the factory, passing up the broad stairway at the left, and make a hurried tour of the various departments where over a thousand men and two hundred women find constant employment.

Passing through the office of the assistant superintendent we enter the main floor of Factory "A," the one first erected. This floor is devoted to the supply department, where all supplies and parts are kept, subject to the call of the foremen of the departments. Next this is the stock room, where all completed goods are stored after the inspector, who with his assistants, occupy the next position, have examined and passed them. Here, also, is the master mechanic's room, the sheet metal shop, and a small portion of the shop-lighting plant, consisting of two 50 horse power dynamos.

In the basement of the building we find the heavy machine shop. The field castings are delivered from the foundry, at the rear door of this room, and by means of many special machines planed and prepared for winding and fitting. An interesting and special machine is used to bore the inside of the field magnets to the peculiar cup shape used by this company, and which so materially adds to the efficiency of the dynamos.

Passing rapidly forward, by some two hundred men working on the castings, we reach the dynamo assembling and testing room, where all the arc light machines are put together, adjusted, and carefully tested for capacity and efficiency. A 90 horse power Corliss engine furnishes the power for this department, and the circuits from the various dynamos are run up-stairs to the lamp testing room, where the current is utilized in the test work going on. Going up, we enter the low portion of the building between Factories "A" and "B." Here are racks for 190 arc lamps, while an ingenious switchboard by the wall enables any line of lamps to be placed on any dynamo in the room below. We notice that all the circuits are of white wire run in glass tubes.

The second floor of Factory "A" is given up to the general offices, drafting rooms and the winding department, where all winding for arc light apparatus is done.

Above this is the large floor given to the manufacture of the details of the incandescent system, such as lamp sockets and collars, fuse boxes, resistance coils, etc. Also the incandescent lamp testing room, where 1,000 lamps may be tested at a time. On one side of this are the general instrument room and the experimental lamp department, the uses of each being manifest from the names.

Crossing to Factory "B" we find the whole upper floor given to the manufacture of over 1,500 incandescent lamps a day. More than 100 girls and many men are here employed in the glass room and general department.

The floor below, excepting the pattern room in the rear, is devoted to the experimental laboratory of Prof. Elihu Thomson, the electrician of the company. His study, the library of reference, and the office of Mr. E. W. Rice, jr., are in the front.

* * In St. Louis, after many months of experimenting and investigating, the Lindell R. R. Company has at last settled down to the adoption of Julien storage batteries and Brush machinery for running its cars. The company considers the system perfect and satisfactory in every regard, after a week's trial.

What Constitutes a Good Carbon Point.

By G. W. Parker, before the National Electric Light Association, Pittsburgh.

From the standpoint of the manufacturer all well-baked carbons that are straight, free from cracks and other similar defects, and made from pure material, are good carbons.

The electric light engineer will say that no carbon is good unless it will center properly and give him a reasonably long life with a good light. He is not at all inquisitive as to the method of their manufacture, provided they give such results.

But as the manufacturer can go no further than to correct any errors in his mechanical processes, the value of the carbon afterwards depends upon the conditions of its use. Such carbons as are described in the first paragraph will in some currents be satisfactory both as to light and life. In others the light may be brilliant and the life too short, or there may be arcs too short or too long, flaming, or other defects arising from the unsuitability of the carbon to the current, there being no inherent defect in the pencil itself. Therefore, to cover the whole ground of this important inquiry, we should also have the carefully compiled statements of your experience of the behavior of carbons burning in your lamps under varying circumstances. From this, results of great value to both sides might be obtained.

There appears to be no trouble in determining what constitutes a good carbon mechanically, but to you a good carbon means one that will give you satisfactory results in your use of it, and there we find several difficulties, without taking into account imperfections in your apparatus. The first is the difference in the strength of the current used in the different systems, and also in many cases in different plants of the same system, the corresponding differences in the resistance of each lamp, and frequently unequal adjustments of lamps in the same plant.

For convenience, we are in the habit of referring to those systems in which a small current and a long arc is used as high tension systems, and those in which a large current and short arc is used as low tension systems.

The requirements of the low tension seem to be a carbon that is hard, well plated, and a good conductor, the latter being the most important.

In the high tension, on the contrary, hardness and conductivity seem to be of secondary importance. There is a tendency to flame and burn unsteadily when a hard carbon is used in these systems, and a softer one sometimes becomes necessary, which in many cases shortens the time in which a lamp will burn without being re-trimmed, but in such case the difference is fully made up in the brilliancy of the light. On the other hand, where a soft carbon is burned in a low tension current, the tendency is to form needle points, which prevents the carbon from centering properly, causes them to heat, and is apt to burn the holder.

Let us pursue the inquiry touching the questions of size, conductivity, mortality, and light, and ascertain if definite relations can be established in regard to them, that may result in guiding us to the selection of perfect carbons for use from a mass of mechanically good carbons.

DIAMETERS.

It is a matter of great interest to know in what manner and to what extent the size of the carbon affects the result in a current of given strength, covering, of course, in the general question of conductivity, the all-important results of light and life.

HARDNESS OR CONDUCTIVITY.

It is well known that a hard carbon offers less resistance to the current, or, in other words, has greater conductivity than a soft one; therefore, in carbons of the same length and diameter, made of the same material, by the same process, conductivity increases and diminishes respectively with their hardness and softness.

In either hard or soft carbons, whatever of conductivity they possess respectively, will be increased or diminished as their diameters are increased or diminished, the length being maintained. It would appear, therefore, that it is possible to make a softer carbon of larger diameter that will be the equivalent in conductivity of a harder carbon of smaller diameter.

MORTALITY OF CARBONS.

Of carbons of the same *hardness* and length, but having different diameters, the larger will, undoubtedly, outlive the smaller. Of carbons of the same *diameter* and length, but diffeing in hardness, the harder will outlive ther softer.

Therefore, a carbon of larger diameter, which is soft may be equivalent to a smaller carbon, which is hard, as to life, just as it has been shown to be equivalent in conductivity.

The life of a carbon is, of course, dependent upon many vicissitudes, such as high winds, broken globes, etc.; but under the same conditions the statement made above is, undoubtedly, a fact.

BRILLIANCY OF LIGHT.

It is well known and admitted that as between hard and soft carbons of the same diameter, the latter will give a more brilliant light.

It is just as well known that in case of hard carbons those of smaller diameter will, within certain limits, give a more brilliant light than those of a larger diameter.

On the above statement of facts it may be regarded as settled, then, that with the same diameter, but differing in hardness, the hard carbon will possess greater conductivity and have a longer life, but with less brilliancy of light; while the softer carbon will have less conductivity and a shorter life, with a more brilliant light.

And, further, that with uniform hardness, but differing in diameter, the larger diameter will have the greater conductivity and longer life, with a less brilliant light: while the smaller diameter will have less conductivity and a shorter life, with a more brilliant light.

The foregoing statements indicate invariably that with greater conductivity light diminishes and life increases; and, conversely, that with diminished conductivity the brilliancy of the light is increased and the life shortened.

In corroboration of this it appears that a small, hard carbon is practically the equivalent of a larger, soft carbon, their conductivity being also equivalent.

Heretofore it has been considered probable that the diameter, candle power, resistance per lamp, conductivity of the carbon point, and strength of current, are all interdependent, and a change in any of them will effect all the others, requiring a counteracting change or adjustment in some of them, in order to restore the proper relations between them.

This, if so, you can readily see is difficult to do; for part of the work is to be done by the manufacturer, and the remainder is under your control.

On the other hand, if the deduction can be properly made from the statements herein presented, that the resistance of the carbon point will determine its capability in respect to light and life in the different currents, the trouble is practically removed. It is not impossible, I think, to construct a machine that will, at no great increase of cost, assort the carbons into groups of uniform resistance or conductivity. Then, with constant currents, clean lamps, perfect connections and insulation, you will ascertain practically that carbons mechanically good will prove to be good, and uniformly so, in actual service.

Much more could be written upon this interesting question, but this paper is already too long. I have noted for your discussion some important points which I hope your experience will enable you to determine definitely if they are well taken or not. I would be glad to have the whole question of the imperfect burning of carbon points thoroughly canvassed, so that manufacturers would get some hints as to what may be done by them in the way of correction when the fault lies at their door. It is especially desirable to be informed if that very disagreeable feature in the burning of carbons called "flaming" is always the effect of one particular cause, and what that cause is.

Mr. Gaslight and his Son Bill.

"My dear Mr. Gaslight, what is the matter?" inquired jaunty young Miss Electra, who delights in shocking people with her smartness. "You look so feeble and yellow. Is it a touch of the jaundice? Come, brighten up and be yourself again."

"No, no, Miss Electra," was the sad response. "I will never be myself again. My whole system is run down. I am weak and haven't a bit of life in me. Oh, my! oh, my! I have had Dr. Wagner (director of Public works) for nearly a year now, and I'm afraid he doesn't understand my case. I feel and I know that I need richer and stronger food, but he will keep me on a low diet, and it breaks me down. The doctor says I am just as strong as I was a year ago, but I know better than that. I guess Dr. Wagner's practice is too big. He attends the Waters, the Cobblestones, the Sweepers, the Sewers, and they all have sickness in their families. No, I've never been altogether myself since Dr. Trust died."

"And how is your son?"

"My son Bill? Oh, Bill is all right. You can almost see him grow. He could not be better, and do you know that it is one of the strange things in my case that the weaker I get the stronger Bill grows. Yes, indeed, Bill's all right, and Dr. Wagner is proud of him. He understands Bill better than he does me."—*Philadelphia Times, Jan. 23d.*

The Relation of Electric Lighting to Fire Insurance.

By S E Barton, of the New England Insurance Exchange, before the Electric Light Convention, Pittsburgh.

In considering the relation between electric light and fire insurance interests, I must confine myself mainly to the situation in New England, because I am familiar with what has been and is now being done there, and I am quite as unfamiliar, except in a general way, with the relations that exist between the two interests outside of that small but lively quarter of our country.

In order that you who live away from New England may better understand what I may say as I proceed, it will be well for me to tell you briefly what kind of an insurance organization we have there.

The New England Insurance Exchange, which exercises a modest control over a part of the fire insurance matters within that territory, with the exception of the city of Boston and State of New Hampshire, is a body composed of the special agents, adjusters, traveling men or so-called field-men, representing the various stock fire insurance companies doing business there—some 150 in number. These men mostly have their headquarters in Boston, which is verily a "Hub" in that respect. They are constantly skirmishing over the territory, individually or in squads of two or more, adjusting losses, and occasionally, through the co-operation of their local agents in the towns and cities, stealing good risks from each other or from some other competitor; but every Saturday finds a large majority of them back in Boston, where they convene in regular session, and consider with legislative dignity any matters of common interest, electric lights included. They swap experiences, swap yarns, swap anything for something better; consequently they are a body of wonderful unanimity in any cause that promises common good to themselves, and justice and fairness to others. They say to electric lights, "Burn, after our inspector has approved the manner in which you are installed and maintained;" and as a consequence there are in New England to-day, not including Boston and New Hampshire, 13,944 arc and 157,845 incandescent lamps, radiating their beautiful bright light where the feeble flicker of the gas-jet and kerosene lamp could not penetrate.

So concerted is the action of these men, that were they, by reason of any necessity, compelled to say that electric lights shall not burn, comparative darkness would once more reign supreme in that fair land; but while they can continue to count upon their fingers the yearly fires caused by this modern illuminant, I think I can safely assure you that their dreaded power of extinguishment will not be exercised.

I have made exceptions of the city of Boston and the State of New Hampshire, the reasons for which are these: The former in its fire insurance matters is supervised by a similar organization to ours, known as the Boston Underwriters' Union, which handles electric lights in the same manner as our exchange. The latter, through antagonistic and unfair legislation, over two years ago caused the absolute retirement from that State of every outside stock fire insurance company, and they now manage that business by themselves. By what light they work we know not; but, judging from their sad experience of the past year, we are led to believe that they work by the unholy light of their own wicked ways.

I have described the character of our exchange principally to show the difference between it and most of the insurance organizations of our country, which are generally composed of officers of companies, or local and general agents in the large cities, between whom, by reason of their greater competitive relations, there exists a less cordial and familiar fellowship; and they are consequently less able to harmoniously and successfully devise and carry out methods of improvement and mutual good.

In the first year of our existence, some five years ago, we realized, after having paid considerable sums for losses caused by electric lights, that our interests demanded the inspection of all such apparatus by some person selected by ourselves, if we were to continue granting permits for the lights, without charge. We were a year or two, in a sort of experimental way, in getting settled down to a perfect system of inspection; but the result of the two years immediately preceding 1887 showed us, for the labor we had undertaken, a loss of less than $8,000 from electric lighting in our territory. We had by that time not only given up all thought of making an extra charge for a permit to use your lights, as we do in many cases for kerosene oil, and in some instances for gas, but we were fast beginning to show our preference for your illumination by granting reductions in our rates of premium. The year 1887 has shown us a loss record from your lights something less than any previous year, notwithstanding the great increase in your installations; and the spirit of recognition of your superiority in point of safety has steadily gained ground, until I am happy to predict that, before another month has passed, the New England Insurance Exchange will have announced its favor in the form of a schedule of reduced rates, which it purposes to make on certain classes of risks where the exclusive use of electric lights is guaranteed. I think in this respect we will have fairly taken the lead.

A proposition to this end was made by the electric light committee of our exchange a year ago; but while we had for two years previous made an occasional reduction in rates, and have done so more generally during the past year, the time has not seemed ripe until now for an open announcement to that effect.

This feeling of preference for electric lights has been very gradual in gaining ground with us, and has reached a general recognition from the fact that the fires from that source have been few in number, and the losses small in amount; and this favorable result has most assuredly been due to our perfect system of inspection. In this claim I am supported by the greatly increased number of fires that are reported as occurring in sections where insurance inspection does not prevail.

That there are in your method of lighting many inherent possibilities of causing combustion and loss of property thereby, I need not claim, because none of you would for a moment deny it; but what I do want to claim, and mean to persist in maintaining, is, that there is no reasonable excuse for any fire to be caused by your apparatus, except in very rare cases, where some unexpected and unavoidable accident may occur.

It is quite possible for you to reduce the fire hazard of your system to the very lowest degree.

It is quite as *impossible* to do so with any other means of artificial lighting. How can any care or control be exercised over the promiscuous use of kerosene lamps, while men, women, and children, including the careless, the thoughtless, the stupid, the old and feeble, the young and weak, are handling them? What can prevent the innocent but agile cat from upsetting the lamp carelessly left in its path, as it is not infrequently accused of doing. Surely no insurance inspector, even with his ubiquitous habits, could prevent such catastrophes.

While greater care and a system of inspection could prevent some of the many explosions in the gas system, they could not prevent combustible material from coming in contact with the open flame, neither in the dwelling, the store, nor the workshop; nor could they prevent an occasional escape of gas through a leak, or a burner carelessly left open; and in that event no amount of cautionary rules could deter the innocent occupants of the premises from going in search of the leak with an open light in their hands.

While our policies distinctly exclude damage caused by explosion unless fire ensues, and then only cover the damage caused by fire, there is usually fire enough ensuing to "ring us in"; and the drawing of the line between the explosion and the fire is usually disastrous to us.

Therefore I hold, that, while no possible human foresight can prevent fires from the old methods of lighting, it is not only possible, but quite an easy matter, to prevent them in your case, if you set about it rightly.

If I were to presume to offer advice in the matter, it would be this: Where insurance inspection is already being practiced, combine among yourselves and support it by paying whatever is reasonable for carrying on the work in an intelligent and economical manner; also by helping them improve their rules and requirements from time to time, as your experience develops new means of safety.

Where such work is not being performed, get together in the same manner, those of you who are operating in that field, and ask the insurance men to appoint an inspector; then submit your work to him, conform cheerfully to his reasonable requirements, and go to the public with his approval. The approval by insurance companies of any lighting, heating, or power device is necessary. The public wants light, heat, and power; but it must have insurance, for on that the great commercial fabric of to-day depends for solidity.

By such inspection you will bring the fire hazard down to a minimum, you will largely increase the growing confidence of the public in your lights; you will rapidly clear away any lingering prejudice with insurance men against you, and, in place of opposition that you may now occasionaly meet with from them, you will readily obtain their fullest indorsement—more than that even, you will doubtless receive positive encouragement from them in the way of concessions in rates in many cases.

The two interests should harmonize and

work together to the greatest degree. You have in your system of artificial lighting great possibilities of reducing the enormous fire waste considerably; while we have, through our indorsement and encouragement, the power to largely increase your development; and the two together can give mankind more light and better light, and they need it.

I do not hold that you are deficient in any degree as to what does and what does not insure safety in your work, but I think you will agree that in the construction and maintenance of your equipments you are sometimes obliged to depend upon those who are not so proficient in their calling as they might be. The good insurance inspector, who gleans his knowledge and experience from all, helps you to educate and improve in usefulness these employes to whom you trust your work. I refer particularly to the construction and dynamo men and the trimmer, and to the latter more particularly. If this functionary had possessed a knowledge of the possibilities of fire from the arc lamp, the losses from electric lighting in New England last year would have been too inconsiderable to mention.

Right here I wish to speak of a habit that sometimes possesses local companies—that of hiring inexperienced help because it is cheap. It is false economy, I think.

Competition, which is very great among you, drives you in some cases to lowering the standard of your material and work. It compels you to figure in every possible way to get the job. Nine out of you may be honestly inclined to maintain the highest degree of perfection, but the tenth one outbids you all by figuring for cheap work. Careful and conscientious insurance inspection brings him up to the rack, or shuts him out; and we all profit thereby.

The question of insulation was referred to in a pointed and timely manner by our friend Haskins a year ago, and his suggestions seem to have taken root in the East. Insulated wire is the rule rather than the exception in those places where insulation is most needed, and painted wire has "lost its grip." The difference in cost is too slight, and in point of efficiency and economy too great, to allow the reform to languish.

The location of central stations seems to be receiving merited attention, but not to that extent which the good of the profession demands. In the past the practice has been to secure power, especially in the smaller places, where it could be had the cheapest, without regard to permanency and surroundings. The result has been, that you have gone into cramped quarters, with hazardous occupations on all sides, above and below you. You have got power by using boilers already being worked well up to the limit of safety, or you have set other boilers in the limited space at your disposal. There have been fires and losses charged to you which you might have escaped by locating more wisely; and, as a consequence, too many insurance men now look upon the electric light station as one of the specially hazardous risks.

Locate by yourselves as much as possible. Build after modern fashions. Do not spare brick walls and cement floors where they will add to your safety; and then you will get lower rates from stock fire insurance companies, or our "Mutual" friend Woodbury will provide for you.

There are in New England, as many of you are aware, a dozen or more good, strong mutual fire insurance companies known as the "Manufacturers' Mutuals." They confine their acceptances of risks to the largest and best manufacturing properties in New England and the Middle States, and to a limited extent in the Southern States and Dominion of Canada. Mr. C. J. H. Woodbury is one of the vice-presidents of the largest of these Mutual companies, and the recognized expert authority for them all. About five hundred of the large manufactories insured by them are lighted by electricity, either arc or incandescent, and very largely isolated plants. They have received the inspection of Mr. Woodbury, and the greater part of those in New England that of Inspector Brophy also. I take pleasure in quoting from a letter on the subject, just received by me from Mr. Woodbury. He says:—

"When electric lighting was first introduced, it was the cause of a great many fires, there being twenty-three fires from this source in the sixty-one mills using it in 1881 and 1882. By April, 1882, all the electric lighting plants in property which was insured by the Mutuals had been changed to conform to the rules for installation which I had prepared in December of the previous year, and since that time we have not had a single fire from electric illumination. I do not know of any fires caused by electric lights which did not owe their origin to a disregard of principles laid down in those rules as essential for safety."

I think that statement bears me out in my assumption as to the almost entire immunity from fires due to artificial lighting that is attainable by the use of your methods, and I ask no better support.

Mr. Ridlon has advanced some excellent deas looking to better work in point of safety in construction and maintenance—that of examination for fitness and qualification of the men who do this work, and the granting of certificates to them if found competent, the same as is done in the case of steam engineers. He would have the board of examiners composed of electrical and insurance experts. My only criticism is that his ideas fall short of the whole necessities. The absolutely impartial inspector is still needed to see that the "tenth man" of whom I have previously spoken does not prosecute his nefarious work without a certificate; also to see that those who hold certificates are not intrusting their work to cheap men who don't hold them, or that the guileless trimmer is not falling into the habit of leaving the bottom off his arc lamps.

I would not occupy your time with technical suggestions—if, indeed, I had any to offer—because they had better be left to printed rules and inspectors; but it may interest you to know to what extent your business has prospered in New England. The following figures are taken from our inspection records, and are probably about right; they are inclusive of Boston, but exclusive of New Hampshire. For comparative purposes I give them as they stood at the beginning of 1886 and also 1888.

NUMBER OF ARC LIGHT CENTRAL STATIONS.

	1886.	1888.
In Massachusetts	26	45
Rhode Island	5	8
Connecticut	9	21
Maine	4	14
Vermont	none	5
Totals	44	93

Increase, 1888 over 1886, 111 per cent.

CAPACITY OF ABOVE IN ARC LAMPS.

	1886.	1888.
In Massachusetts (including 2,168 in Boston in 1886, and 2,475 in 1888)	3,693	7,305
Rhode Island	831	1,961
Connecticut	782	3,311
Maine	520	1,465
Vermont	none	415
Totals	5,826	14,457

Increase, 1888 over 1886, 148 per cent

NUMBER OF INCANDESCENT LAMPS FROM CENTRAL STATIONS.

	1886.	1888.
In Massachusetts (including 9,000 in Boston in 1888)	8,600	74,500
Rhode Island	600	2,200
Connecticut	none	11,050
Maine	400	8,100
Vermont	none	1,400
Totals	9,600	97,250

Increase, 1888 over 1886, 913 per cent.

NUMBER OF ARC LAMPS IN ISOLATED PLANTS.

	1886.	1888.
In Massachusetts	459	721
Rhode Island	416	731
Connecticut	223	332
Maine	10	50
Vermont	58	128
Totals	1,166	1,962

Increase, 1888 over 1886, 68 per cent.

NUMBER OF INCANDESCENT LAMPS IN ISOLATED PLANTS.

	1886.	1888.
In Massachusetts	16,003	40,619
Rhode Island	4,140	9,546
Connecticut	2,117	11,050
Maine	1,860	6,908
Vermont	none	475
Totals	24,120	68,598

Increase, 1888 over 1886, 184 per cent.

Total arc lamps, 1886. 6,992; 1888, 16,419.
Increase, 1888 over 1886, 135 per cent.

Total incandescent lamps, 1886, 33,720; 1888, 165,848.
Increase, 1888 over 1886, 392 per cent.

Total arc and incandescent, 1886, 40,712; 1888, 182,267.
Increase, 1888 over 1886, 348 per cent.

Those of you who may know the ratio of increase in other sections of the country, for the corresponding period, can judge if New England insurance supervision is a detriment to your business or otherwise.

A whole year without any considerable fire loss in our country from electric lighting would be a splendid record, but none too good for any of us to contemplate. While such a result is far outside the bounds of probability, in the present condition of things, it is well inside the bounds of possibility. As well might we hope to revolve the earth from east to west as to hope for anything short of millions of dollars of fire loss annually from the old methods of illuminating by combustion—the candle, the gas, and the kerosene oil flame, and the accompanying friction match.

How can We Protect our Watches against the Influence of Magnetism?

By Philip Lange, before the National Electric Light Association, Pittsburgh.

I have been invited to deliver to this convention an address on the influence of electric currents upon small magnetic matter. I can comply with this request in no better way, perhaps, than to devote myself especially to the discussion of this subtle influence as applied in particular to the delicate mechanism of our watches. Every man among us has doubtless been often impressed with the idea that absolute accuracy is the most desirable quality a timepiece can possess; that reliability is most essential to render efficient a guide so frequently consulted as the watch. You will therefore acknowledge the real importance of the question as to how we can best protect our timepieces from the influences of a magnetism that must render them inaccurate and unreliable. Since the introduction of powerful dynamos has taken place in large electrical establishments, and in the many buildings supplied with independent and separate lighting plants, it has become evident that the watches carried by persons coming in proximity to the dynamos (whether such persons be constantly employed near the dynamos, or only visitors to the works, it matters not), are very likely to become magnetized. Once the influence of magnetism, the time pieces must very soon show the effects by either losing or gaining time, or stopping altogether; and the cause thereof is such, from its very nature, as would be liable to puzzle even an expert watchmaker to remove. The advent of electricity in its modern and manifold branches of utility has forced upon us the importance of this question: How can we prevent this magnetism from gaining a damaging influence upon our watches; or, if not prevented, how can we best and most speedily repair the damage done?

Let us not look upon the question lightly, but rather in all earnestness. Let us bear in mind that, while the powerful dynamo in the engine-room of the manufactory, the business house, or the ocean steamship, sends forth its currents through many lines to furnish light or power, it sends forth also a very different influence, and one that makes mischief with the watch carried by the engineer or electrician, the visitor to the works, or the captain, or the pilot who may happen to approach for a moment within the influence of such a dynamo. Let us not forget that, in the latter event, serious results may follow, for, by the captain's chronometer, in conjunction with the compass, the great ship is sailed. We should bear in mind that, in the manufacture of our best watches, the object of the maker is to confine in the smallest space possible the greatest strength and durability. In order to accomplish this object he finds it necessary to use, for the principal parts of the watch, hardened steel, a material decidedly susceptible to the influences of magnetism. The hair-spring and the balance-wheel, vital parts of the watch, are thus frequently constructed; and even though the balance be made of a combination of metals, the steel in the little points on the wheel may be attracted to the little steel screws necessary to perfect firmness in the larger mechanism of the watch; for these screws may be readily charged with magnetism of sufficient force to be long retained and to exert a continual influence over the other magnetic matter. The escapement-wheel—likewise of steel if durability be desired—becomes easily magnetized also, and its movement is seriously retarded. Then the hair-spring, with its delicate coils close together, may be so polarized that the coils on the side next to the nearest steel screw will all adhere to each other, and play havoc with the motion of the watch.

Thus our very best timepieces are most susceptible to the influence which may, and often does, retard them to the extent of several hours a day.

In my work as an investigator of this subject, which has extended over a period of several months, I have formed three separate solutions of the problem: First, to have the watch made of material that cannot be magnetized; second, to enclose the works in an iron case, so as to shield the vital parts of the watch; and third, to apply efficient means to demagnetize the watch that has not been favored with the safeguards.

With regard to the first solution, I have had occasion to experimentally test its efficiency. I have applied the most complete magnetic tests to watches made by a well-known watch company, which were claimed to be perfectly free from all magnetic influences. The hair-spring and balance-wheel of these watches are made of an alloy of palladium. I have no hesitation in saying, after subjecting these watches to the strongest magnetic influences in the Westinghouse Electric Works, that their claim to recognition as non-magnetic timepieces is fully sustained. I have had one of these watches perfectly timed to run with another, and subjected the two to opposite extremes as regards magnetism, yet discovered no deviation in their time-keeping. The one was wholly free from the magnetic influence; the other was running at a point between the pole-pieces of a most powerful magnet. I have watched both of them closely for weeks, without being able to detect any difference in their time.

Taking the hair-spring and balance-wheel from a watch, I have placed them upon a little cork-float in the water, and then approached them with a most powerful magnet, without being able to detect the slightest motion of the little float or its burden; whereas the ordinary steel hair-spring and balance wheel, subjected to a similar test, were so strongly attracted that they not only moved the cork float, but jumped from it to the magnet instantly.

While it is true that the screws and a large portion of the other mechanism in these watches is made of steel, yet all the delicate movements in the works are so entirely non-magnetic that, although the steel parts should be charged with magnetism to the highest degree, there would be no perceptible effect exerted upon the running of the watch.

Concerning the second solution of the problem, that is, shielding an ordinary watch against magnetic influences by enclosing it in an iron case, I would say that I have not personally experimented with them; but acquaintances of mine entirely competent to do so have given me an excellent idea as to what such watches are capable of. Watches in such cases have been very successful in resisting the ordinary influences of the dynamo room. But I would not advise that they be exposed to the influence of very strong fields, because in that case they would be magnetized and lose time.

Now for the third solution of the problem. Since it is true that comparatively few non-magnetic watches are in use, and that there are great many of the ordinary watches with steel works the question comes up naturally: How can we best demagnetize the watches if they have become injuriously magnetized?

An old way of doing this was in placing the magnetized timepiece in close proximity to a dynamo, then revolving the watch rapidly by means of some mechanism and slowly removing it from the magnetic influence. This is a very unreliable cure at best, and in many instances, quite ineffective. A much better method has presented itself to me. I had occasion recently, while constructing instruments for the alternating current, to observe some facts in connection with this kind of current and its peculiarities, which were suggested to me as being entirely available for use in the process of demagnetizing watches. In sending an alternating current through a solenoid, without breaking the circuit in the latter, I found that the steel core had lost its magnetism entirely. Magnetizing the core as strongly as I might before this operation, it would be, as I discovered, entirely demagnetized after submission to the process described. Then I found the same proposition to be equally true as applied to a whole handful of steel particles. They might adhere to each other ever so strongly before the operation; but if I endeavored to pick one of them out of the solenoid with the circuit undisturbed, the steel particle would come out entirely alone, wholly demagnetized and free from attraction to the others. Then I tried a watch whose steel pieces were thoroughly charged with magnetism, and I found that the same process exerted the same effect upon the watch as upon the steel core or upon the many particles of adhering steel. It was utterly demagnetized in all its parts, perfectly cured of its magnetic ailment. It would be unsafe to bring such a perfectly restored watch again within the influence of magnetism, unless the owner be desirous of again resorting to the still reliable process described. The solenoid need not be described to electricians. It is a very simple contrivance, filled almost to the top with soft iron wire, leaving just room enough at the top, if designed for the purpose described, to allow the insertion and removal of the watch in the manner noted. Any person can apply the test successfully, and, if it be in a jeweler's store, or any other place lighted by incandescent lamps supplied for alternating current, the person need only remove the lamp from its socket, insert an attachment plug in its stead, connecting the current with such a solenoid, dip the watch in the hollow end of the solenoid, and, after leaving it in there a while, remove it without disturbing the circuit. In this way a perfect cure for magnetized watches might be applied in any store, factory, or other establishment having alternating incandescent lighting plant. In conclusion, I have only to say that the first solution of the problem described above, namely, that of getting perfectly non-magnetic watches, is the best and safest one for those whose timepieces are liable to be subjected to magnetic influences. I may also add that the third method or cure described demonstrates the wonderful resources of the alternating system of electricity, which, though it may work damage like other systems, has yet within its own qualities a perfect curative power, which cannot be claimed for the continuous or direct current.

"Independent Engines."

THE DISCUSSION OF MR WM. LEE CHURCH'S PAPER BY THE ELECTRIC LIGHT MEN.

We presented Mr. Church's paper last week. It provoked the following discussion:

DR. MOSES: I would like to ask Mr. Church, then, what is about the average size of independent engine that he would recommend.

MR. CHURCH: I think the question is not governed by the size of the engine. I think it is governed by the size of the dynamo, and that, in turn, is governed by the nature of the circuits which have to be laid out You have got to discover what your distribution of light is to be; then adapt your dynamos to that; then adapt your engine to the dynamos. It is not a primary question.

DR. MOSES: Is it not in this regard, perhaps? It might not be considered advisable to establish a central station that did not represent a certain curve of use of incandescent light.

MR. CHURCH: Without professing to have any knowledge whatever of the economics of station management, it seems to me that a large station will naturally run in the direction of uniform sizes of dynamos throughout, for the one reason that that involves simply the carrying of one line of spare parts, and more ready interchangeability. Of course, in a station in which the light fluctuates as much as in this that I show, the smallest dynamo should be adapted to the minimum load that obtains over the greatest length of time. But I should determine, as far as possible, what my minimum load was to be; make that my smallest unit; and after that bring all the subsequent units to the same power, or, if found better, to still larger units, as indicated here.

DR. MOSES: Another question, if you please. Does not the efficacy of these independent engines depend also a great deal upon the simplicity of the engine? If you have a complicated, very high speed engine, that requires a great deal of attention—oiling, and looking out for cylinder heads, and all that—is it not perhaps advisable to adopt, in those cases, an exceedingly simple engine? I have in my mind a station I saw in Philadelphia. The gentleman who represents it might now say something in regard to it.

MR. CHURCH: I simply wanted to say with reference to that question that I sometimes play whist. I do not wish the gentleman present to think that I have returned my partner's lead in this case. [Applause.] I should rather be excused entirely from entering at all upon remarks of that character. I think the Association will do me the credit by acknowledging that I made my remarks as general as possible. It is purely a point as to whether we shall go direct from our engine to our dynamo or shall we go around from the elbow to the thumb? I would not want to enter into discrimination between engines at all. [Applause.]

DR. MOSES: I feel, Mr. President, as if we are all here for the purpose of eliciting the truth on that matter. I myself am very anxious to know that, because I happened on one occasion to require the use of a high speed engine, and found that it was a very difficult thing to manage where the complication of the engine interfered with the ease of mind of the engineer He had to be running it nearly all the time. His attention was nearly always occupied with it. Therefore I asked that question. I answered it for myself on a subsequent occasion where I caused an engine of very much simpler construction to be substituted for it. I won't tell this gentleman that it was an engine that he represented, or he might object to it. But it was. [Laughter.]

MR. SMITH, of Detroit: I think that Mr. Church has treated this question from a very broad standpoint, and I think that he should be congratulated on that. There are certainly at least half a dozen high-speed engines admirably adapted for electric lighting, and anything Mr. Church has said on the blackboard in reference to any one of them will apply to all. I do not see any reason for bringing in here the different makes of engines. I am not an engine man myself. I do not represent any engine at all. But Mr. Church's paper was put on a broad basis, and I think we should keep it on a broad basis, and not bring it down to any particularity.

MR. SMITH, of Pittsburgh: Mr. Church's paper is limited to incandescent stations. The use of a small engine in arc stations has been very much condemned. In an arc station you know about what your light is going to be. If you know your load is going to be 500 horse power you can stop your engine at pretty nearly its full load. There the big engine is undoubtedly the more economical. But in an incandescent station there is no regulation as to the amount of load. We must keep that point clearly before us—that this discussion is limited exclusively to incandescent work. There are comparatively few incandescent stations that are running with shafting. Most of them are running with independent engines.

MR KERR: There is another thing, in the preliminary part of this discussion, that I wish to draw attention to. It has been called to the attention of the association each time a power discussion has arisen, and I do not see the need of mentioning it again, except for the fact that a great many men have a misconception of large versus small engines as against subdivided versus non-subdivided power. Let us not, in any discussions that follow here, talk about the difference between 60 horse power engines and 100 horse power, and whether it is better to have 60 or 75 or 125 horse power. The thing is a broad matter and not limited to the size of the engine. It is subdivision versus non-subdivision.

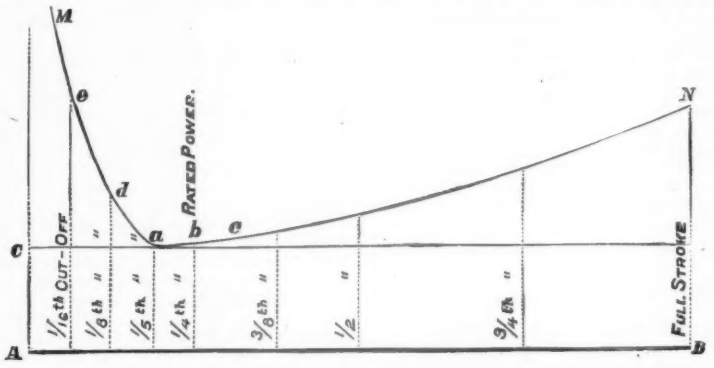

FIG. 1.—W. L. Church's diagram, giving efficiency curve of a 40 horse power variable cut-off engine.

EXPLANATION—LIMITS OF HIGH EFFICIENCY.—Between *a* and *c*, or 325 to 450 horse power. All other loads above or below these points show rapid fall in efficiency, *i. e.*, rapid rise in rate of steam consumption. The point *e* in the curve shows rate of steam consumption for 100 horse power, while *d* represents that for 200 horse power on the 400 horse power engine. The diagram being plotted from observed facts, shows conclusively that such an engine can be run with high efficiency only between loads *a* and *c*, a moderate range below and above the rated power.

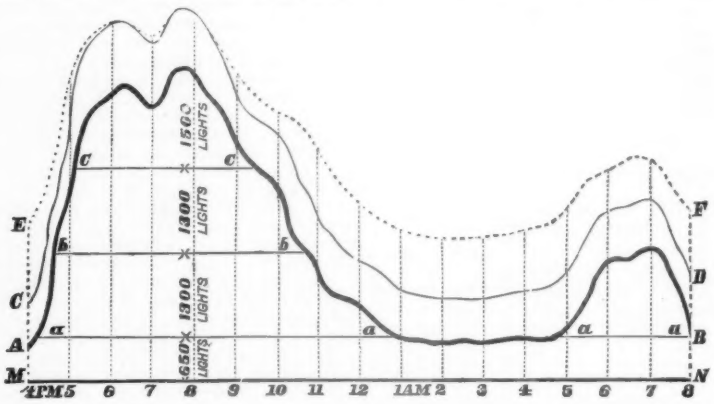

FIG. 2.—Church's diagram, based on actual performance in two stations, one operated by single large engine, and the other by independent engines. See p. 9, REVIEW Feb. 25, 1888.)

EXPLANATION—WITH SINGLE LARGE ENGINE.—*A B* variable load between 4 P. M. and 8 A. M. *C D* gross load, including friction of transmission. *E F* steam consumption required for net work *A B*. Area. *A B F F* = total loss expressed in coal = about 50 per cent. of total fuel used in the night's run.

WITH INDEPENDENT ENGINES.—One 60 horse power for 650 lights, two 125 horse power for 1,300 lights each, and one for 1,500 lights.

The 60 horse power engine is run at maximum efficiency throughout the night, indicated by *a a a a* As load rises, one 125 horse power engine is started at 4.10 P. M., and driven at maximum efficiency till 11.45, and continued at lower efficiency till 12.45 (line *b b*).

Another 125 horse-power engine starts at 4.40 P. M. and runs at maximum efficiency till 9 30, and stops at 10.45, its last hour only showing falling efficiency (line *c c*). The fourth engine runs only from 5 to 9.30 P. M. at nearly maximum efficiency.

The contrast between the two methods of installation is most striking, as thus graphically represented. Each engine runs at its best range of efficiency, and only so long as its load is called for, then stops, and with it all consumption of steam, leakage, radiation, and wear and tear, and plenty of time is left for inspection and repairs if required.

MR SMITH, of Detroit: Mr. Church spoke about the economy of small engines as compared with large ones. He is perfectly right in that, because the greatest loss in power is always on the small load. But I think that the question might be carried a little bit farther. The high speed engines, as a rule, are not as economical in coal as the larger engines, for the reason that we cannot get as perfect expansion; we cannot get as good compression lines on a single valve automatic engine as we can on an engine with four valves, as in the Corliss type But there is another means of getting at that economy which is due to high expansion, and that is in compounding. It is known that all the ocean steamers now are run on triple compounds; that is, the steam is taken at high pressure in one cylinder and expanded into the second cylinder, and from the second into the third, and the very highest economy that has yet been gained has been attained with those engines. Now the same thing can be done with the high speed automatic engines which we are now using for electric lighting, and with very great economy, and the tendency, I think, which has already started in Europe, is coming to this country, and we will very shortly have economical high speed constant revolutions and constant regulating in the engines for direct running of dynamos. There are, as I understand, several of the prominent engine builders now who are bringing out compound engines for high speeds, and I think the economy that has been talked about for the large slow speed engines will be met in that particular very shortly.

MR. SMITH: Mr. Smith has made a remark about which I would like to argue with him, without taking the time of the meeting to do it, about the compression not being as good on a single valve engine as on a four valve engine.

MR. SMITH: Do not let Mr. Kerr forget the idea that I am not in favor of high compression.

MR. KERR: Perhaps it may take but a moment to explain. On a slow running engine you set the exhaust valve so that it makes an exhaust closure at ⅞ of the stroke. That does not vary as the load decreases. Therefore, the entire internal surface of the cylinder is exposed to the temperature of the exhaust steam at the whole stroke, or ⅞ of it. With a single valve engine, as the cut-off decreases, the exhaust closure occurs earlier, until, when you get down to a very light load, you only expose your cylinder for one-fourth of the time to the temperature of the exhaust steam; and, therefore, the movement of the compression of a single valve engine not only is better under light loads than a four valve engine, but it is very much better.

MR. SMITH: If I understand it rightly, the lighter the load, the shorter the cut-off, the greater the compression. Therefore, a greater surface of the cylinder is exposed to condensed steam than in the other.

MR. KERR: Therefore a less time is given for the bad influence of the temperature of the exhaust steam to be exerted on the surface of the cylinder. This is a long discussion; we will continue it in our next. [Laughter.]

MR. RICE: Mr. Kerr made the statement that it was not small engines versus large engines, but the division of power versus the non-division of power. Now, it seems to me there is not any member here but who would agree to the subdivision of power, broadly taken, in cases where the loads vary largely. We all agree to that. I do not believe any man can dispute that one moment. It seems to me the question comes down to the relative efficiency of the engine direct from the dynamo—a high-speed engine—and that driven by means of countershafting by a large engine. Suppose you have a station of 2,500 horse power. Now the question is: Is it more economical to use that 2,500 horse power engine, or to put in a number of 100 horse power engines—the 100 horse power engines driving direct—the 2,500 driving from a countershaft?

MR. KERR: Was that the subject of Mr. Church's paper?

MR. CHURCH: I think I did allude to that. I said that the smallest unit should be adapted to the lightest load. I am disposed to take a very practical view of this question. I think there is but one way to settle this thing absolutely and finally, as to which is the most economical, and that is, not to argue it from any standard of compression lines or any theoretical data, but to take the results of those stations which operate two systems, and extend it into the cost of the various items per lamp hour. That will settle it. Every well managed station has its nightly report sheet. Extend the one item of coal alone out to its course per lamp hour. That will give the relative coal economy; but that is not enough. Then you must extend the collateral items of repairs, and all these various items, extended out per lamp hour, and then you can combine them and ascertain what the grand total is, as to the question of direct or countershafted engines. Anything short of that is argument and not demonstration.

MR. WRIGHT: I have recently taken charge of a station in New England, where we are using large engines with countershafting. We are using somewhere near five and one-fifth pounds of coal per horse power per hour, which I attribute in a great measure to our want of subdivided power. Of course there we have an extreme case. But it will not be an extreme case in the future. On Saturday night only do we have an ampere line that approaches anywhere near Mr. Church's illustration. On the ordinary week days we close at 6 o'clock, so that our highest ampere line is maintained for a short time only, and then very rapidly falls. I happen to have here with me some papers I brought for Mr. Church. I promised them to him a long time ago, and in preparing to come to Pittsburgh I happened to remember them and copied them to bring them with me; and if Mr. Church will allow me, for a moment, to change his diagram for a little bit, I will show you where our line comes. I think Mr. Church has shown us conclusively that there is a saving here with the load maintained for several hours at its maximum. Now, how much greater must it be if I get a load for five days in the week? That is, more like that. [Illustrating.] We are coming to the time when we will all have early closing, and our loads will be maintained for a very short time.

MR. SMITH, of Pittsburgh: Has any one noticed this peculiarity of our service in Pittsburgh? If it is dark for an hour in the morning, between 9 and 10 o'clock, our ampere curve will jump away up. No matter how bright the day gets after that, it does not drop any. [Laughter.]

MR. KERR: Mr. Church's paper mentioned the difficulty of driving incandescent lamps from very slow-speed engines on account of the fluctuation from revolution to revolution. That is a thing which can be noticed in a great many places. There is another thing which goes hand in hand with that. It is quite a well-known fact that a slow-speed engine has comparatively small friction. It is generally acknowledged so. The friction of the engine is small. Now, put fly-wheel enough on a slow-speed engine so that it won't make the lamps flicker, and you will find that it has a very large friction. The reason that a slow-speed engine has small friction is because it has not fly-wheel enough, and the number of tons of fly-wheel to give it good regulation makes it a high friction engine. That is a thing which is very little thought of in electric lighting, and when thought of is only thought of too late, when they take out the first fly-wheel and put in a second. That applies not at all to our class.

Additional Convention Notes.

Diehl's unique combination sewing machine motor and fly-wheel was on view in the corridor.

B. E. Sunny, of telephone fame, appeared to advantage in his new position as an electric light man.

There is more snap in an electric light convention than can be found in any other quasi-scientific gathering.

Prof. George Forbes and Prof. A. Reckenzaun, of England, were interested attendants on the sessions of the convention.

Glazier came on from Chicago Tuesday morning, and although threatened with being thrown overboard several times, managed to arrive in fairly sound condition.

The Solar Carbon and Manufacturing Company, of Pittsburgh, had an interesting collection of coppered and plain carbons from $\frac{5}{16}$th to 1 inch, and of three grades of hardness, marked H, HH, and HHH.

ELECTRICAL PATENTS

(Copies of any Patents in the following List wil be sent to any address on receipt of twenty-five cents.)

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING FEB. 21, 1888.

378,107 Printing telegraph; Daniel E. Pike, New York, N. Y., assignor to the Western Union Telegraph Company, same place.

378,115 System of electrical distribution by secondary batteries; John S. Sellon, Hatton Gardens, County of Middlesex, England, assignor to the Electrical Accumulator Company, of New York.

378,121 378,122 Galvanic battery; Hugo Walter and William E. H. Marsh, Cincinnati, Ohio, assignors to the National Galvanic Battery Company, of New York.

378,126 Electro-magnetic bell; Joseph Wetzler and Sigmund Wetzler, Hoboken, N. J.

378,175 Telegraph cable; William R. Patterson-Chicago, Ill., assignor to the Western Electric Company, same place.

378,181 Multiple telegraphy; Charles Selden, Baltimore, Md.

378,202 Electric time, temperature and burglar alarm and call bell; Hans P. F. Jensen, Browne W. Webb and Jens Jensen, London, County of Middlesex, England.

378,250 Telephone switch; Joseph R. H. Hinton, Baltimore, Md.

378,259 Electric railway; Charles T. Mason, Sumter, S. C., assignor to the Maryland Electric Motor Manufacturing Company, Baltimore, Md.

378,298 Telephonic transmitter; Moses G. Farmer, Eliot, Me.

378,320 Alternating current transformer. 378,321 Transformation and distribution of electric energy; Rankin Kennedy, Glasgow, County of Lanark, Scotland, assignor of one-half to Robert Dick, same place.

378,332 Telegraph key and instrument; William A. Melbourne, Swanwick, Ill.

378,339 Display stand for non-magnetic watches; Alfred C. Smith, New York, N. Y.

378,375 Core for dynamo electric machines; Winceslas C. Rechmanwski, Paris, France.

378,385 Telephone receiver; Alonzo W. Brown, Evanston, Wyo.

Any person having valuable patents or ideas in Electricity, and not having sufficient funds to demonstrate them, may obtain money and business experience and use of powerful dynamo by writing to Box 356, New York. State date of patent and full particulars.

PATENTS.

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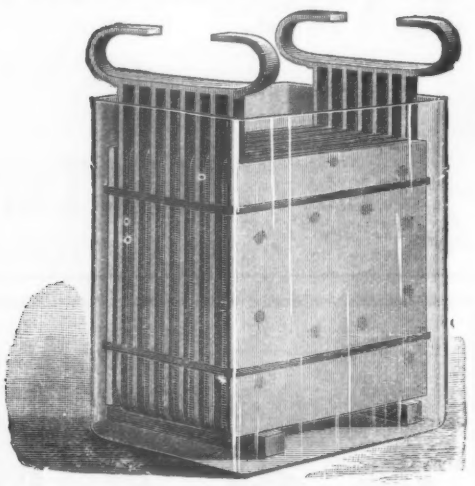

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